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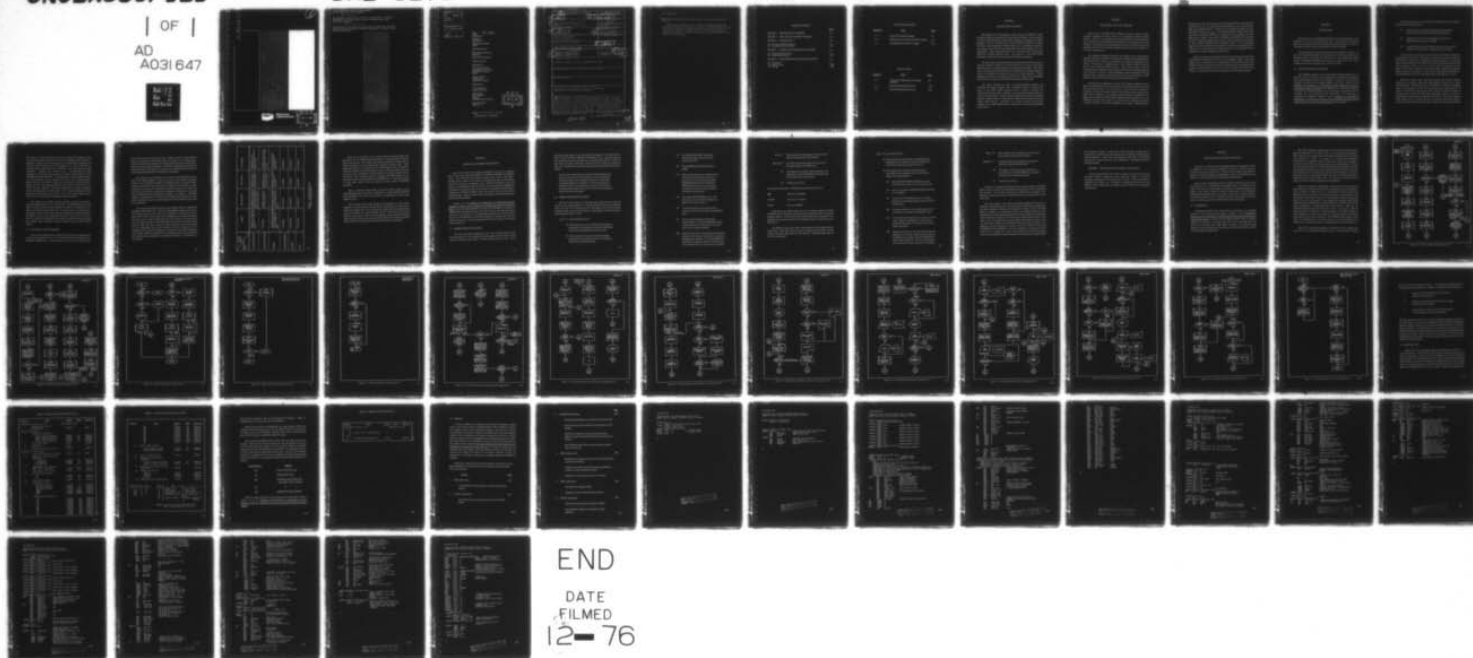
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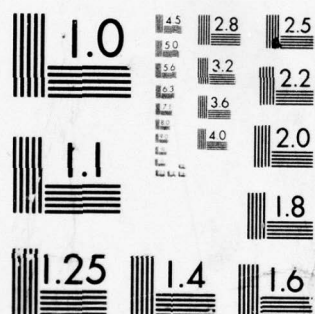
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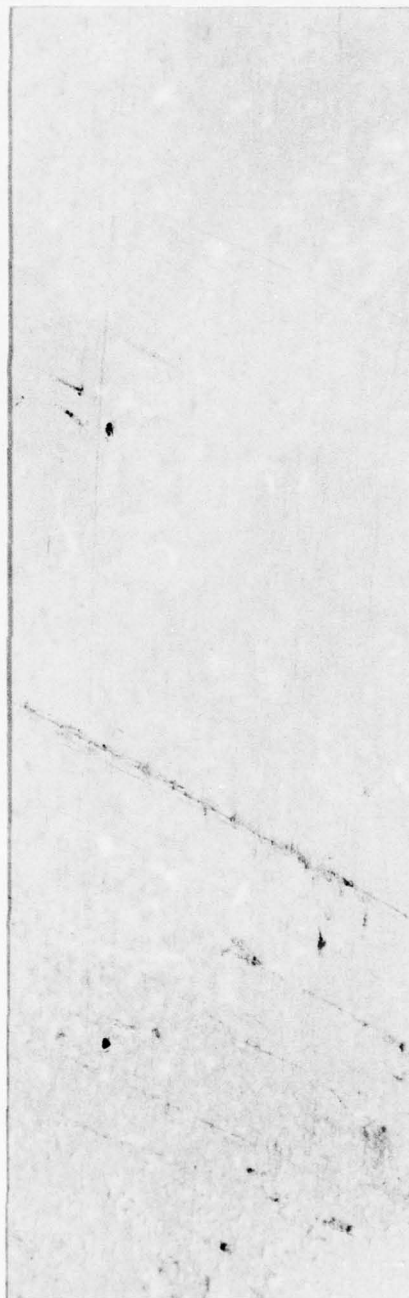
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BRL Project 2521

RPIE Symbol Placement
Accuracy

Final Technical Report

October 22, 1976

Submitted to:

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Fort Belvoir, Virginia
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△ RPIE Symbol Placement Accuracy Project was to locate and correct this problem.

This report discusses the cause of symbol placement problems and documents the program changes made. Section 2 describes the source of the noted symbol placement errors, and section 3 discusses the minimization of those errors. Section 4 provides additions to the viewer operating sequence, and section 5 documents the changes that have been made to the original RPIE programs. X

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SECTION 1

INTRODUCTION & SUMMARY

The Replacement of Photographic Imagery Equipment (RPIE) is a high-resolution, high-speed, large-format image restitution system. Its major purpose is to produce high-resolution orthophotos from panoramic photographs. A symbol generator is part of the system and is used to overprint symbols on the output orthophoto. Upon completion of RPIE development, it was found that symbols on some output orthophotos were not being placed accurately enough to meet user requirements. These symbol placement errors were noted only in the system's UNAMACE ONLINE operating mode. The objective of the RPIE Symbol Placement Accuracy Project was to locate and correct this problem.

The major source of symbol placement errors was traced to mechanical and electronic alignment problems in the viewer portion of the system which caused positioning errors in output imagery with respect to the symbols. After these errors were corrected, the RPIE software was modified so that viewer alignment errors are checked and corrected as a part of normal operation. Similar potential error sources in the printer portion of the system were investigated, and corrections for them were included in the software modifications.

This report discusses the cause of symbol placement problems and documents the program changes made. Specifically, Section 2 describes the source of the noted symbol placement errors. Section 3 discusses the minimization of those errors. Solutions to newly discovered symbol placement errors are also described. Section 4 provides additions to the viewer operating sequence. Finally, Section 5 documents the changes that have been made to the original RPIE programs. Familiarity with system operation and computer programs of the original RPIE system is necessary for a complete understanding of this report.

SECTION 2

THE SYMBOL PLACEMENT PROBLEM

When work on the RPIE Symbol Placement Accuracy Contract began, correlator averaging errors were thought to be causing the symbol placement problem. However, the magnitude of symbol placement errors soon indicated that a similar but more devastating problem must exist. Through observation and analysis of viewer operation, the principal source of error was found to be viewer alignment with both the mechanical alignment and the electronic alignment of the viewer being incorrect.

The mechanical alignment problems were largely in the viewing optics, making it difficult or impossible for an operator to make precision measurements with the instrument. Also, the y_1 coupling to the encoder was slipping with servo motion. The electronic misalignment was in the centering of the CRT optical axes on their respective floating marks. These three problems were the immediate culprits responsible for symbol placement errors, but any mechanical error causing the operator to make inconsistent manual measurements and any electronic error causing the correlator scans not to see and measure as the operator would see and measure will result in symbol misplacement.

The reason viewer alignment is critical is that alignment problems result in faulty measurement of the grid of sixty points on the overlap area between the input and control photos. To see that this is true, note that the operator establishes the photo coordinate system of each photo when he manually performs interior orientation. The model coordinate system is established by the program as a function of control photo coordinates and data given to it on the UNAMACE magtape. Now assume for a moment that the mechanical alignment is perfect and only the electronic alignment is not right. During grid point

measurements a point that the operator would manually measure as having model coordinates X_m, Y_m, E_m and input photo coordinates x_{p1}, y_{p1} , the correlator might automatically measure as having the same model coordinates but with input photo coordinates x_{p2}, y_{p2} . (The model coordinates would remain stable because only input photo coordinates are adjusted to remove parallax. The input photo point is forced to match the control photo point.) What the correlator measures as conjugate image points are not, in truth, conjugate points according to the manually established photo coordinate system. If the mechanical alignment as well as the electronic alignment is incorrect, even the manual point measurement is wrong because the relative position of the floating mark has changed since interior orientation was performed.

Faulty measurement of the grid points results in a resection and third-order transformation computation that does not fit conjugate images. The entire output photo at the printer then is substantially in error, but the error does not become obvious until symbols are observed. Symbols are placed according to the erroneous model-to-photo fit and are seen to be offset from their correct location. In reality the symbols are just symptomatic of the broader problem.

SECTION 3

THE SOLUTION

Once the source of the noted symbol placement error was identified, it was necessary to find a way to minimize that error. The first half of this section deals with the solution found for the alignment problem discussed in Section 2. The solution involves hardware maintenance and program changes.

The second half of this section discusses symbol placement in general. As part of the Symbol Placement Accuracy Project, all sources of symbols in all operating modes were studied for potential error, even though only header symbols in UNAMACE ONLINE mode have thus far found to be in error. Some changes were made in the programs as a result of the study.

3.1 THE NOTED PROBLEM'S SOLUTION

The immediate solution to the noted symbol placement problem was to align the viewer by fixing the viewer alignment errors mentioned in Section 2. The primary long-term solution to the problem is to perform the maintenance necessary to keep the viewer aligned properly at all times. Section 4 of the Handbook for Replacement of Photographic Imagery Equipment, Volume II, Viewer System Instruction Manual is the "Maintenance" section of the Handbook. It contains the recommended procedures for maintenance and adjustment of the correlator and servo subsystems, both Bendix-built. For instructions on maintaining the OMI-built equipment see the Handbook of Operating and Maintenance Instructions for the AS-11A Photogrammetric Analytical Plotter Group, Volume I: Viewer and Coordinatograph, published by OMI.

As a secondary solution to the problem, the RPIE programs were modified to perform the following functions:

- (1) Allow for small scan alignment adjustments to be made by the operator as part of the viewer's operating sequence.
- (2) Diagnose major errors in viewer alignment and warn the operator that maintenance is required.
- (3) Compute symbol placement offsets to be used at the printer to correct for minor electronic misalignment at the viewer.

The first function is performed in conjunction with the interior orientation of each photo at the viewer. The operator is asked to insure that the center of the scan's axes coincides with the floating mark at an index point. The floating mark remains stationary at the middle of the index point while the operator uses the scan alignment knobs on the viewer panel to center the image of the index point on the scan as it appears on the monitor scope. Because the alignment knobs are limited in the amount of correction they are capable of delivering, the scan and floating mark must be well aligned before this adjustment is made.

During the normal viewer operating sequence, the operator manually measures four conjugate image points, called alignment points, on the control and input photos. Normally they are well distributed in the photos' overlapping area. If the operator has taken care to measure them accurately and if the viewer is mechanically aligned, the points provide four good examples of accurate pairs of model and input photo coordinates which can be used to accomplish the second and third functions listed above. The set of alignment point measurements are saved until after the grid of sixty points has been measured and the resection and third-order transformation have been computed.

Then, using the computed resection and transformation, the program converts the saved input photo coordinates into their corresponding model coordinates. Because of residual errors in the resection and transformation computation and because of minor offsets in the electronic alignment, it is not expected that the computed model coordinates will be identical to the saved accurate model coordinates. However, they should be close. The differences in model coordinates are calculated and printed on the CRT terminal under the title "ALIGNMENT POINT OFFSETS". The average X and Y model coordinate offsets over the four points then are computed. If either of the average offsets is greater than fifty micrometers in value and if the operator has been careful in aligning the scans and measuring alignment points, there must be errors in the viewer electronic alignment. When such a large offset is found, the program prints a warning message to the operator. The message indicates that viewer maintenance operations may be needed. If so, the printed alignment point offsets may be of some help in diagnosing the alignment problem.

The average X and Y model coordinate offsets are stored in the disk photo file by the VIEW program for use at the printer. The PRINT program adds the offsets to given accurate model coordinates of symbols to compensate for the error in the viewer's model-to-photo fit. As long as the error is small (viewer misalignment is minor), the offsets will help to position the symbols correctly. The "given accurate model coordinates of symbols" come from two sources. They are found on the UNAMACE tape's header record, and they are derived from control stage coordinates read from punched cards to define offline symbols.

3.2 SOLUTIONS TO OTHER PROBLEMS

If the viewer is aligned well, the above-mentioned program changes correct for errors in positioning header and control offline symbols in the RPIE system's UNAMACE ONLINE mode. (Header symbol errors are the only ones that have

been noticed in system operation thus far.) However, there are four different sources of symbols and six possible modes of operation in the RPIE system. Under the contract all combinations of symbols and modes were investigated for potential symbol placement problems. The following paragraphs discuss in detail discoveries made, while Table 3-1 summarizes the changes made in handling the various operating-mode/symbol combinations at the printer.

As a result of the investigation, two new errors in symbol placement were found in the PRINT program. First, in the case of input offline and manual symbols in the UNAMACE ONLINE and OFFLINE modes, the original PRINT program converted the given input photo coordinates of the symbols to model coordinates by using only the orientation elements computed at the viewer. The third-order transformation coefficients were ignored. Consequently, the symbols were not being positioned as accurately as possible. As a solution, the PRINT program was changed to use the third-order transformation coefficients as well as the orientation elements in determining symbol model coordinates from input photo coordinates.

The second error discovered involves control offline symbols in UNAMACE ONLINE and OFFLINE modes. There the original PRINT program assumed that the control photo used at the viewer was an orthophoto. In reality the control photo can be either a frame photo or an orthophoto, and the stage coordinates read from cards to define symbol positions must reference the control photo used. A change was made in the PRINT program to check for the frame control situation. When that case is found, the stage coordinates are first transformed to the corresponding frame photo coordinates and then, using data on the UNAMACE tape, the photo coordinates are converted to the model coordinates of the symbol. When the control photo is an orthophoto, only the first conversion (from stage to photo coordinates) is necessary since photo x, y and model X, Y are identical.

Symbol Source Operating Mode	Header	Control Offline	Input Offline	Input Manual
UNAMACE ONLINE	Changed to correct for small viewer alignment errors.	Changed to correct for small viewer alignment errors and to check for frame control photo.	Changed to use a more accurate photo-to-model routine.	Changed to use a more accurate photo-to-model routine.
UNAMACE OFFLINE	Unchanged.	Changed to check for frame control photo	Changed to use a more accurate photo-to-model routine.	Changed to use a more accurate photo-to-model routine.
PROFILE	Unchanged, but symbols will be accurate only if viewer alignment is good.	Unchanged, but symbols will be accurate only if viewer alignment is good.	Unchanged. Symbols cannot be placed accurately.	Unchanged. Symbols cannot be placed accurately.
UNAMACE MODEL	Unchanged.	Not allowed.	Unchanged.	Unchanged
RECTIFY	Not allowed.	Not allowed.	Unchanged.	Unchanged.
COPY	Not allowed.	Not allowed.	Unchanged.	Unchanged.

Table 3-1 - Summary of Changes
Made in Printing Symbols

Beside the two correctable errors mentioned above, another problem area was discovered. In PROFILE mode input offline and manual symbols cannot be placed with accuracy. The symbols' input photo coordinates are transformed to model coordinates by using approximate orientation elements only. These orientation elements are computed by the VIEW program from the operator-measured coordinates of the four alignment points. They were meant to be used merely as an aid in profiling at the viewer and not in a photo-to-model routine at the printer. Some thought was given to changing the PRINT program to not allow input offline and manual symbols in PROFILE mode. It was finally decided to retain these symbols with the warning that they cannot be positioned accurately.

Again in PROFILE mode, header and control offline symbols will be correctly placed only if the viewer is aligned well. Unlike UNAMACE ONLINE mode, PROFILE mode does not lend itself to correcting for small viewer alignment errors.

One final observation made during the investigation was that printer alignment is critical when the symbol source is input offline or input manual. Unless the floating mark in the viewing path is aligned with the printing optical axes, input offline and manual symbols will be offset from their correct locations. The reason for this is that mis-alignment causes the photo coordinate system used by the laser scan in printing to be offset from the photo coordinate system defined by the operator during interior orientation at the printer.

SECTION 4

VIEWER SCAN ALIGNMENT PROCEDURES

This section provides scan alignment procedures that now are a required part of the viewer's operating sequence in UNAMACE ONLINE and PROFILE modes. When followed, the procedures remove small x and y scan offsets, insuring that the center of the scan for each stage coincides with the floating mark for that stage as the operator sees it. With the exception of these scan offsets, the VIEW program assumes that the viewer unit is perfectly aligned both mechanically and electronically. If the viewer is not aligned well, the program (operating in UNAMACE ONLINE mode) will be able to tell and will issue a warning message. However, the warning will not appear until one input photo has been processed completely.

Section 4 of the Handbook for Replacement of Photographic Imagery Equipment, Volume I, System Description and Operating Procedures Instruction Manual is the "Operating Instructions" section of the Handbook. It contains the original RPIE operating procedures into which the new scan alignment procedures must be integrated. In the following discussions of the new procedures Section 4 of the Handbook is referenced frequently to indicate how that integration should occur. The new procedures add less than a minute to the viewer's total running time.

4.1 PREPROCESSING PROCEDURES

The first step toward aligning the scan must be taken before on-line processing begins. In the original preprocessing sequence (see Section 4.1) four interior orientation index points on each control photo and four interior

orientation index points on each input photo are identified. This identification occurs in both UNAMACE ONLINE and PROFILE modes. One index point on each control photo and one index point on each input photo will now be used for more than just interior orientation. They will be used to align the control and input scans. Consequently, an additional step required during preprocessing is as follows:

As soon as the index points on a photo have been identified, pick one of the points to use for scan alignment. The selected point should be the point with the highest contrast; i.e., a dark point on a light background or a light point on a dark background. If all four index points are identical in contrast, as is the case for most input photos, any one of the four will do. Mark the selected point on the print of the photo.

4.2 VIEWER OPERATING PROCEDURES

The rest of the changes in the operating instructions all occur in Section 4.6, the viewer operating sequence. The first additional step for scan alignment occurs just after the control photo has been loaded and the first interior orientation index point has been measured. Specifically, the following step is inserted between steps 17 and 18.

(17.5) P: ALIGN CONTROL SCAN

R: If this index point is not the point selected during preprocessing for scan alignment, depress the SKIP button on the viewer panel and continue with step 18.

R: If this index point is the point selected during preprocessing for scan alignment, perform the following steps in their specified sequence:

- (a) Set the MONITOR SCOPE VIDEO knob located at the lower left corner of the viewer panel to V2.
- (b) Set the MONITOR SCOPE SCAN knob to NORM.
- (c) Make sure that the scan as it appears on the screen of the monitor scope is centered on the screen. If it is not centered, turn the POSITION VERTICAL and the POSITION HORIZONTAL knobs on the monitor scope to move the scan in the x and y directions and thereby center the scan.
- (d) Turn the red PMT POWER button on. The index point and its surrounding imagery will appear on the monitor scope.
- (e) To improve visibility on the monitor scope, remove its front screen and adjust the INTENSITY knob.
- (f) At the viewer panel open the door of the control subpanel. Using the ALIGNMENT X2 and Y2 knobs, position the index point at the center of the scan as closely as possible.
- (g) Depress the GO button. The index point will become magnified on the monitor scope so that the scan can be aligned more carefully. Use the ALIGNMENT X2 and Y2 knobs to place the center of the index point at the center of the scan. Be as precise as possible.

- (first h) When satisfied with the alignment of the scan with the index point, depress the GO button.
- (alternate h) If unable to satisfactorily align the scan with the index point, depress the SKIP button.
 - (i) The imagery on the monitor scope will return to its normal size. Turn PMT POWER off and replace the front screen of the monitor scope.
 - (j) Continue with step 18.

To summarize, the button combinations allowed during step 17.5 are

SKIP	-	The scan is not aligned.
GO SKIP	-	The scan is not aligned.
GO GO	-	The scan is aligned.

If the scan is not aligned during step 17.5, the program repeats its "ALIGN CONTROL SCAN" command at each subsequent index point until the command has been followed. At the fourth index point the SKIP button is ignored. Consequently, if the control scan has not been aligned by then, it must be done at the fourth point.

The alignment of the input scan is nearly identical to the alignment of the control scan. The added step for input scan alignment occurs after the first interior orientation index point has been measured. Inserted between steps 33 and 34, it is as follows:

(33.5) P: ALIGN INPUT SCAN

R: If this index point is not the point selected during pre-processing for scan alignment, depress the SKIP button on the viewer panel and continue with step 34.

R: If this index point is the point selected during pre-processing for scan alignment, perform the following steps in their specified order:

- (a) Set the MONITOR SCOPE VIDEO knob located at the lower left corner of the viewer panel to V1.
- (b) Check to see that the MONITOR SCOPE SCAN knob is set to NORM.
- (c) Turn the red PMT POWER button on. The index point and its surrounding imagery will appear on the monitor scope.
- (d) To improve visibility on the monitor scope, remove its front screen and adjust the INTENSITY knob.
- (e) At the viewer panel, open the door of the control sub-panel. Using the ALIGNMENT X1 and Y1 knobs, position the index point at the center of the scan as closely as possible.
- (f) Depress the GO button. The index point will become magnified on the monitor scope so that the scan can be aligned more carefully. Use the ALIGNMENT X1 and Y1 knobs to place the center of the index point at the center of the scan. Be as precise as possible.

- (first g) When satisfied with the alignment of the scan with the index point, depress the GO button.
- (alternate g) If unable to satisfactorily align the scan with the index point, depress the SKIP button.
- (h) The imagery on the monitor scope will return to its normal size. Turn PMT POWER off and replace the front screen of the monitor scope.
- (i) Continue with step 34.

If the scan is not aligned during step 33.5, the program repeats its "ALIGN INPUT SCAN" command at each subsequent index point until the command has been followed. At the fourth index point the SKIP button is ignored. Consequently, if the input scan has not been aligned by then, it must be done at the fourth point.

The final change in the viewer's operating sequence occurs only in UNAMACE ONLINE mode after the resection and transformation computations have been completed. When the slash response is typed in step 50, the VIEW program computes the differences between the operator-measured model coordinates of the four alignment points and the model coordinates of those same points computed according to the resection and transformation results. If the viewer unit is well-aligned and if the scan alignment procedures in steps 17.5 and 33.5 have been followed, these differences will be random and small. As a diagnostic aid, the differences are listed at the CRT terminal and are called "ALIGNMENT POINT OFFSETS". (If all four points are not listed, do not be concerned. It is possible for a point's model coordinates to be indeterminate.) From the individual point offsets the program then computes an average X offset

and an average Y offset. If either one of these offsets is greater than 50 micrometers in absolute value, the program knows something is wrong with the viewer's alignment. Either the scan alignment steps were not performed correctly or the viewer hardware is out of adjustment. The program prints the following message:

WARNING: THE VIEWER UNIT MAY NEED TO BE ALIGNED

If this warning persists from model to model, even after you have been extremely careful in aligning the control and input scans, it is time for maintenance operations to be exercised at the viewer. (The values printed as alignment point offsets may be helpful in determining the source of the problem.) If the warning does not reappear, assume that the viewer's alignment is satisfactory.

SECTION 5

DOCUMENTATION OF PROGRAM CHANGES

This section documents the specific changes made in the programs in order to implement the new functions mentioned in Section 3.1 and to make the corrections described in Section 3.2. Since all of the changes made modify or append the original programs, documentation consists of modifications and additions to the original flowcharts, inputs/outputs, and listings.

Due to a lack of test data not all of the changes documented in this section were actually tried. Specifically, measurements made at a comparator and punched on cards were not available or obtainable for checkout purposes. The result is that changes relating to offline symbols and/or to the UNAMACE OFFLINE operating mode may not be correct. Great care was taken, however, not to make mistakes in theory. Should measurements from cards be used on the system in the future, any errors found should be trivial coding bugs.

5.1 FLOWCHARTS

Each flowchart page in this section either is entirely new or is a modified version of one of the flowchart pages in Section 4 of the Programming Documentation for Replacement of Photographic Imagery Equipment, Volume I, Program Descriptions. In either case its proper position within the original flowcharts is indicated in the upper right-hand corner of the page where the name of the flowchart and a page number are found. The flowchart pages (fourteen in all) are divided into three figures each of which represents a major area of change as discussed below.

The first five flowchart pages (Figure 5-1) are involved in allowing scan alignment adjustments to be made as part of the viewer's operating sequence. After each index point measurement on the control and input photos a new "align scan" subroutine is called. Its purpose is to control operator/program communication in aligning the input or control scan. In doing so, it schedules a new clock function, the "wait for go or skip" clock function (see page 5 of Figure 5-1). This function monitors the GO and SKIP viewer panel buttons and returns to the program when one or the other has been pushed by the operator. When the first GO button occurs, the align scan subroutine helps the operator to center the measuring mark on the index point by shrinking the scan size which magnifies the image of the point on the monitor scope. The scan size is returned to normal when the operator is finished adjusting the scan's alignment.

The next four flowchart pages (Figure 5-2) are concerned with computing symbol placement offsets and, in the process, diagnosing viewer mis-alignment. The one addition to VIEW PAGE 19 is a processing box which indicates that alignment point measurements are saved after they have successfully been used to compute an approximate resection. The only changes on page 2 and page 4 of Figure 5-2 are in two connectors. Their numbers were changed to insert VIEW PAGE 28A between VIEW PAGE 28 and VIEW PAGE 29. On VIEW PAGE 28A the actual computation of symbol placement offsets occurs. Note that the UNAMACE photo-to-model (UPTM) routine is used to convert the alignment points' input photo coordinates to model coordinates. The UPTM routine has been changed to use viewer data, particularly the transformation coefficients, when directed to do so by an argument. The UPTMPR routine prepares viewer data for the UPTM call; i.e., it puts the data into a format acceptable to the UPTM routine. Neither the UPTM or UPTMPR routines have been flowcharted.

The last five flowchart pages (Figure 5-3) deal with all the changes that have been made in the PRINT program in order to correctly position symbols

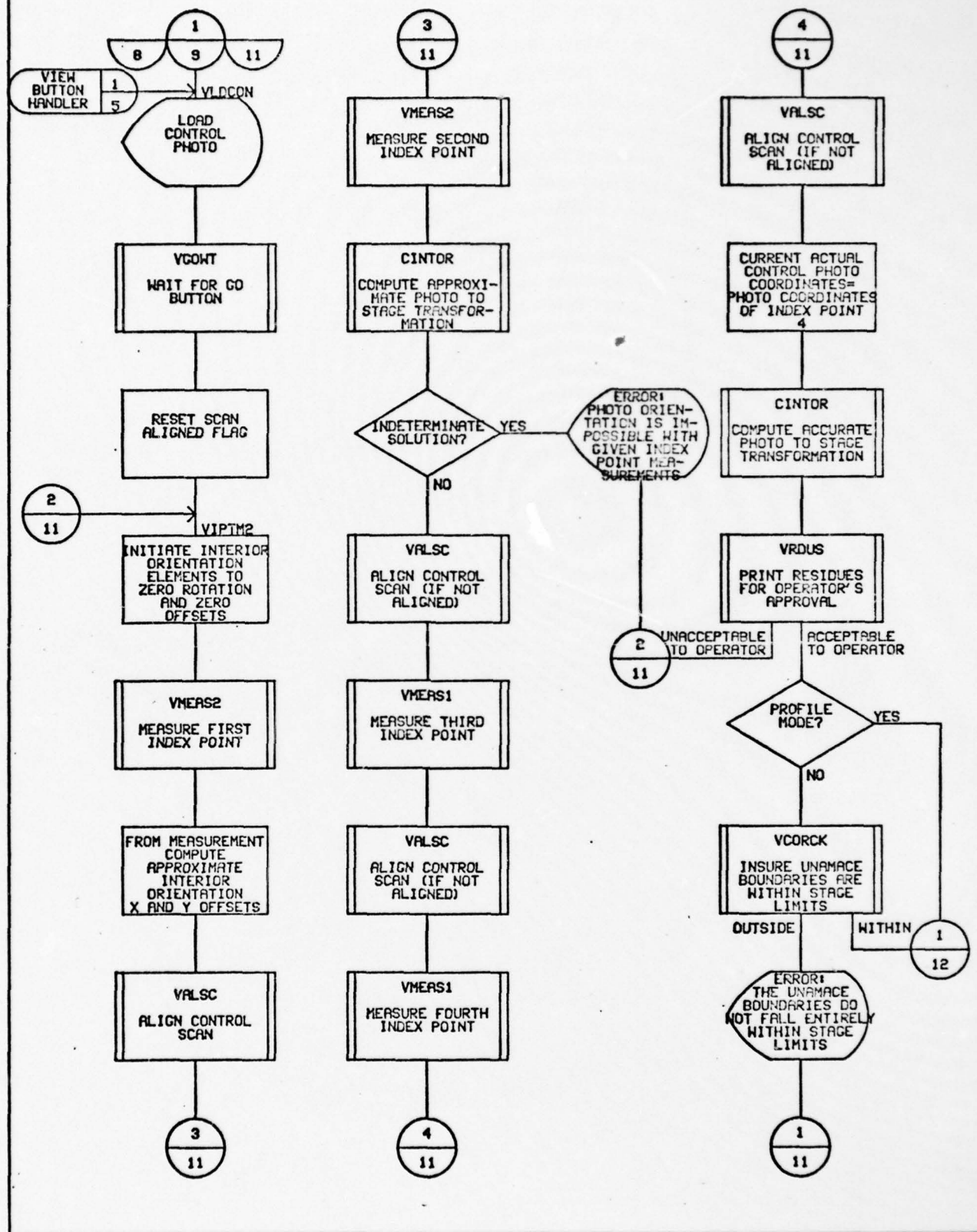


Figure 5-1 - Align Scan Flowchart Changes (1 of 5)

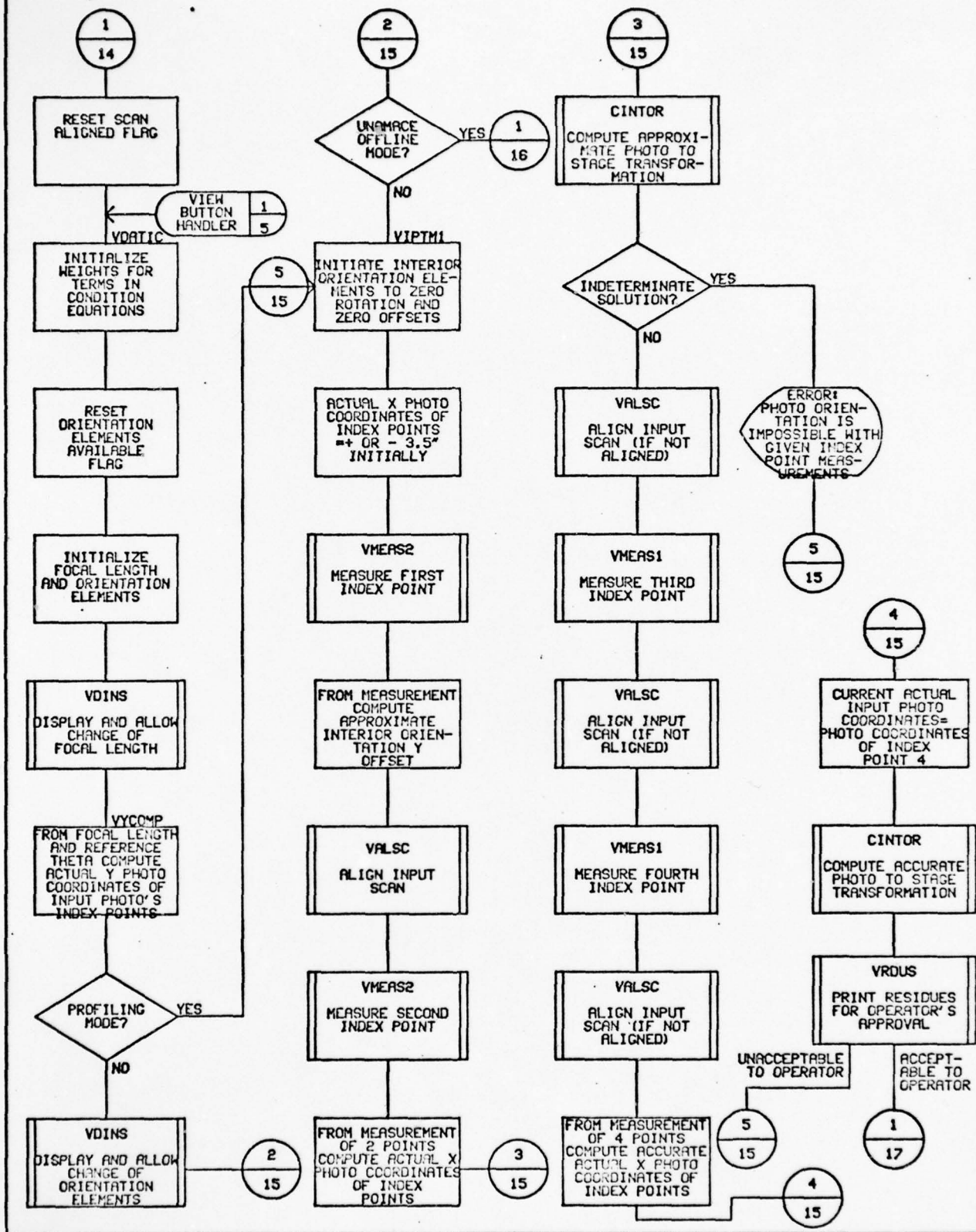


Figure 5-1-- Align Scan Flowchart Changes (2 of 5)

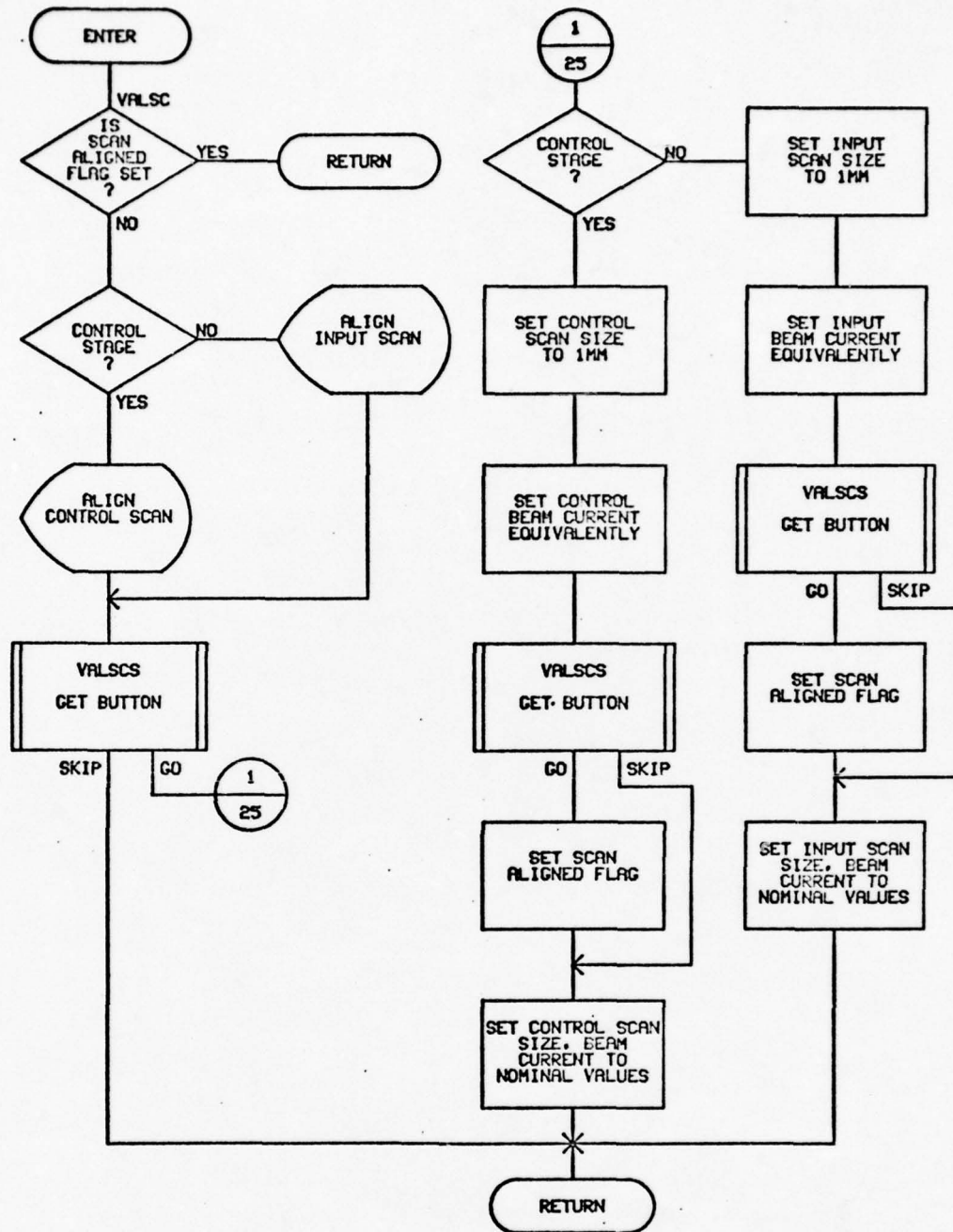


Figure 5-1 - Align Scan Flowchart Changes (3 of 5)

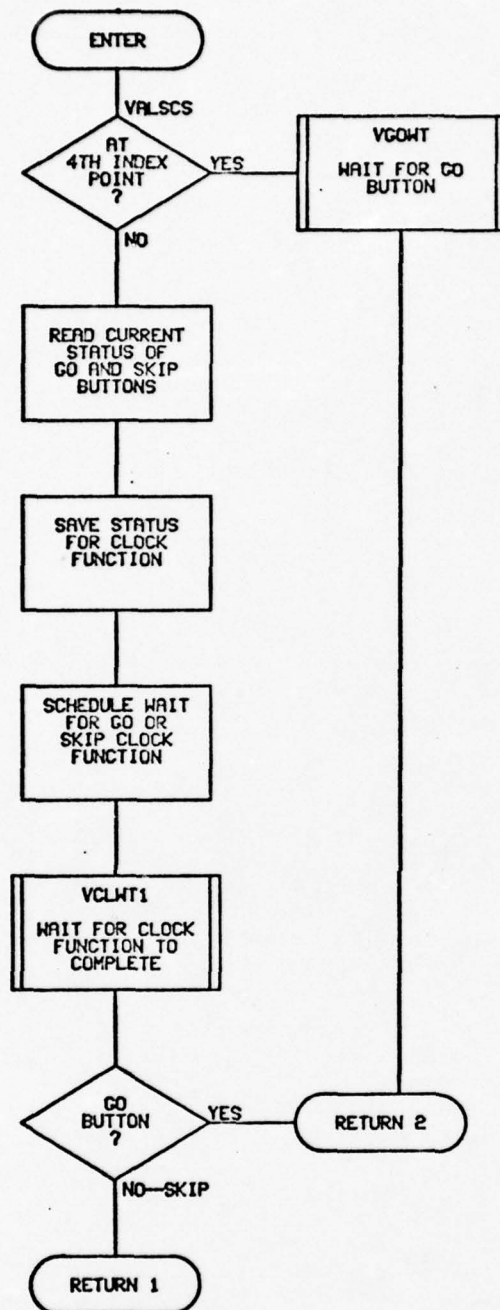


Figure 5-1 - Align Scan Flowchart Changes (4 of 5)

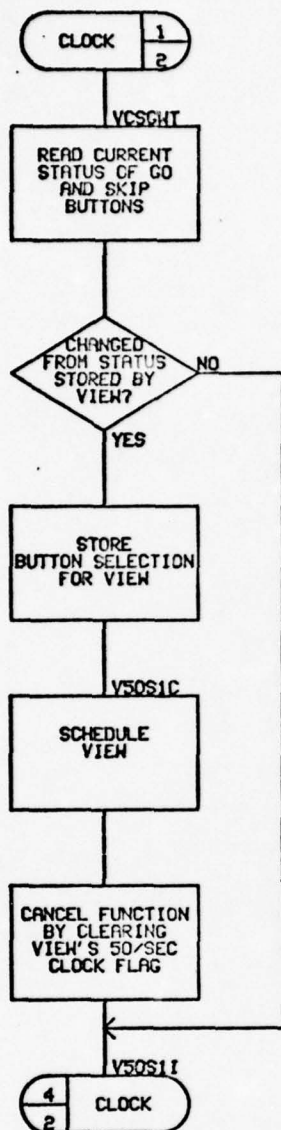


Figure 5-1 - Align Scan Flowchart Changes (5 of 5)

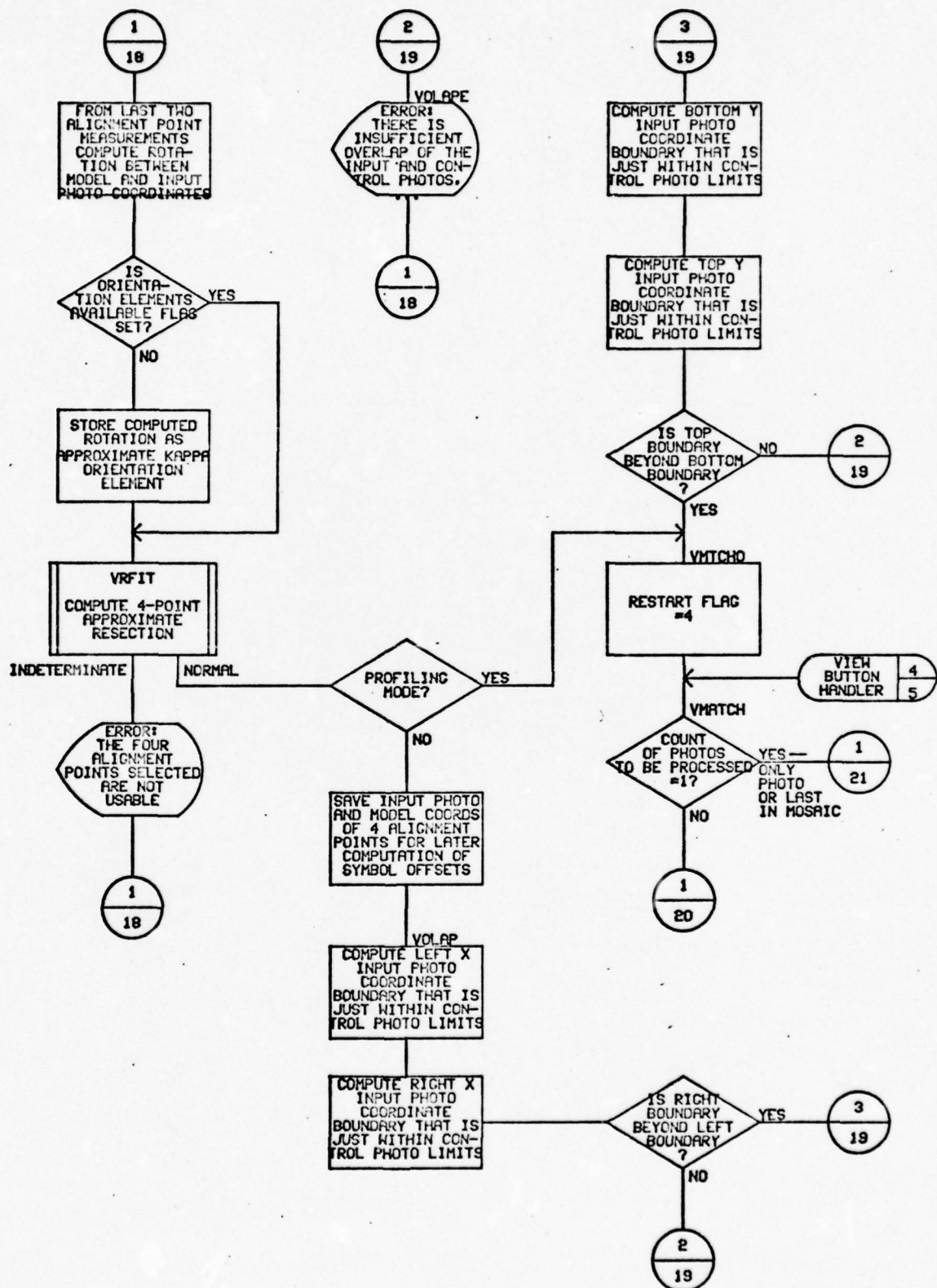


Figure 5-2 - Symbol Placement Offsets Flowchart Changes (1 of 4)

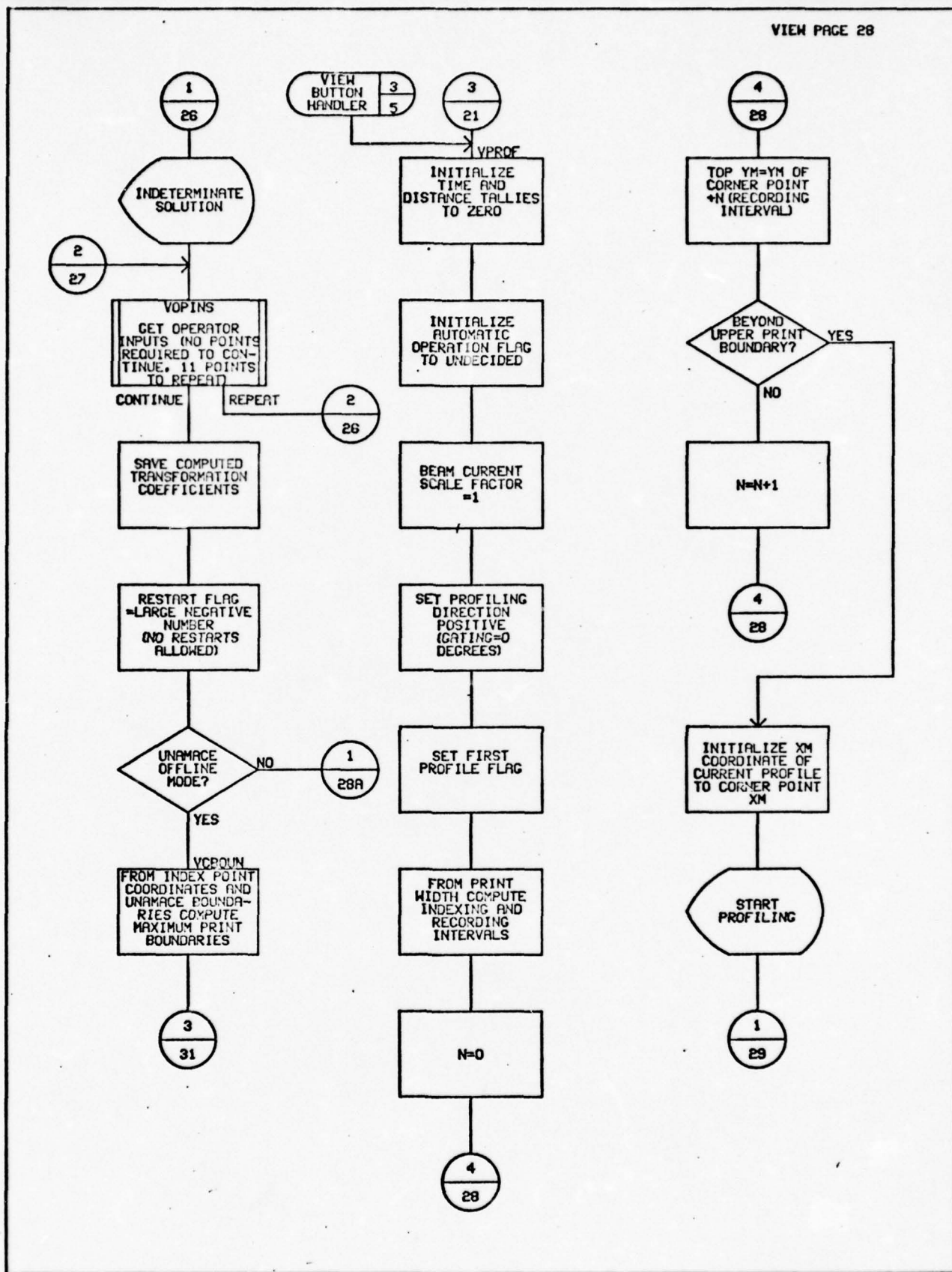


Figure 5-2 - Symbol Placement Offsets Flowchart Changes (2 of 4)

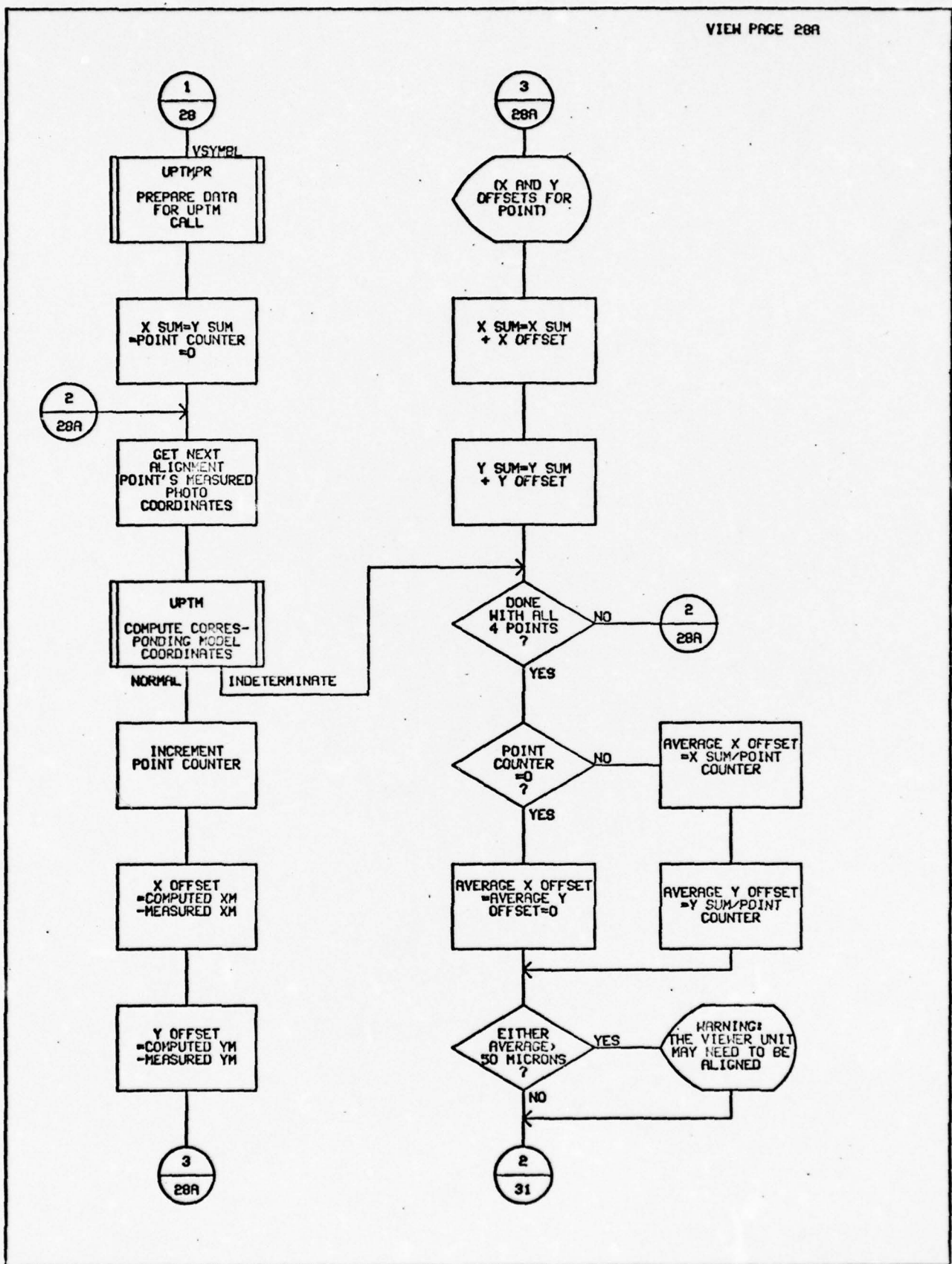


Figure 5-2 - Symbol Placement Offsets Flowchart Changes (3 of 4)

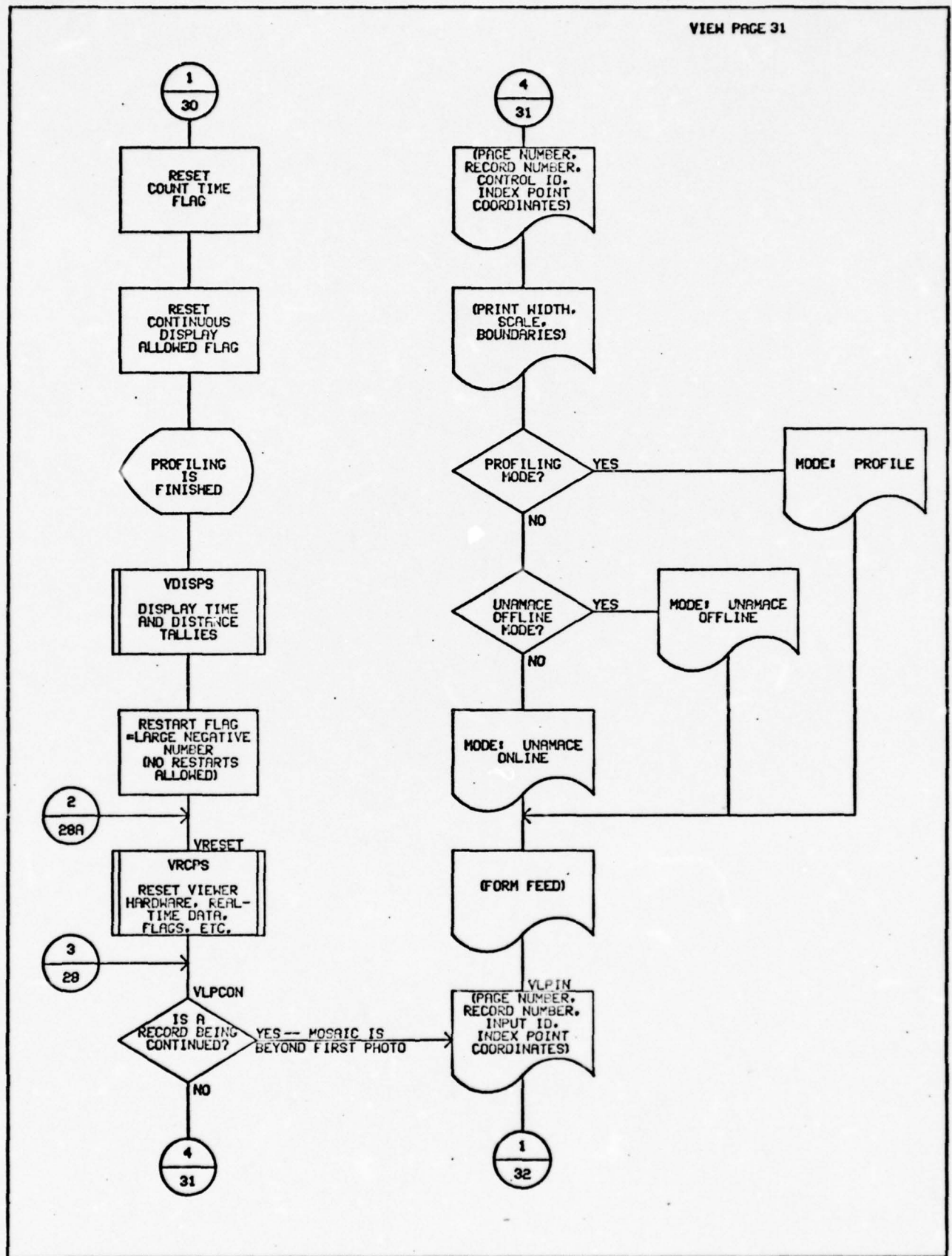


Figure 5-2 - Symbol Placement Offsets Flowchart Changes (4 of 4)

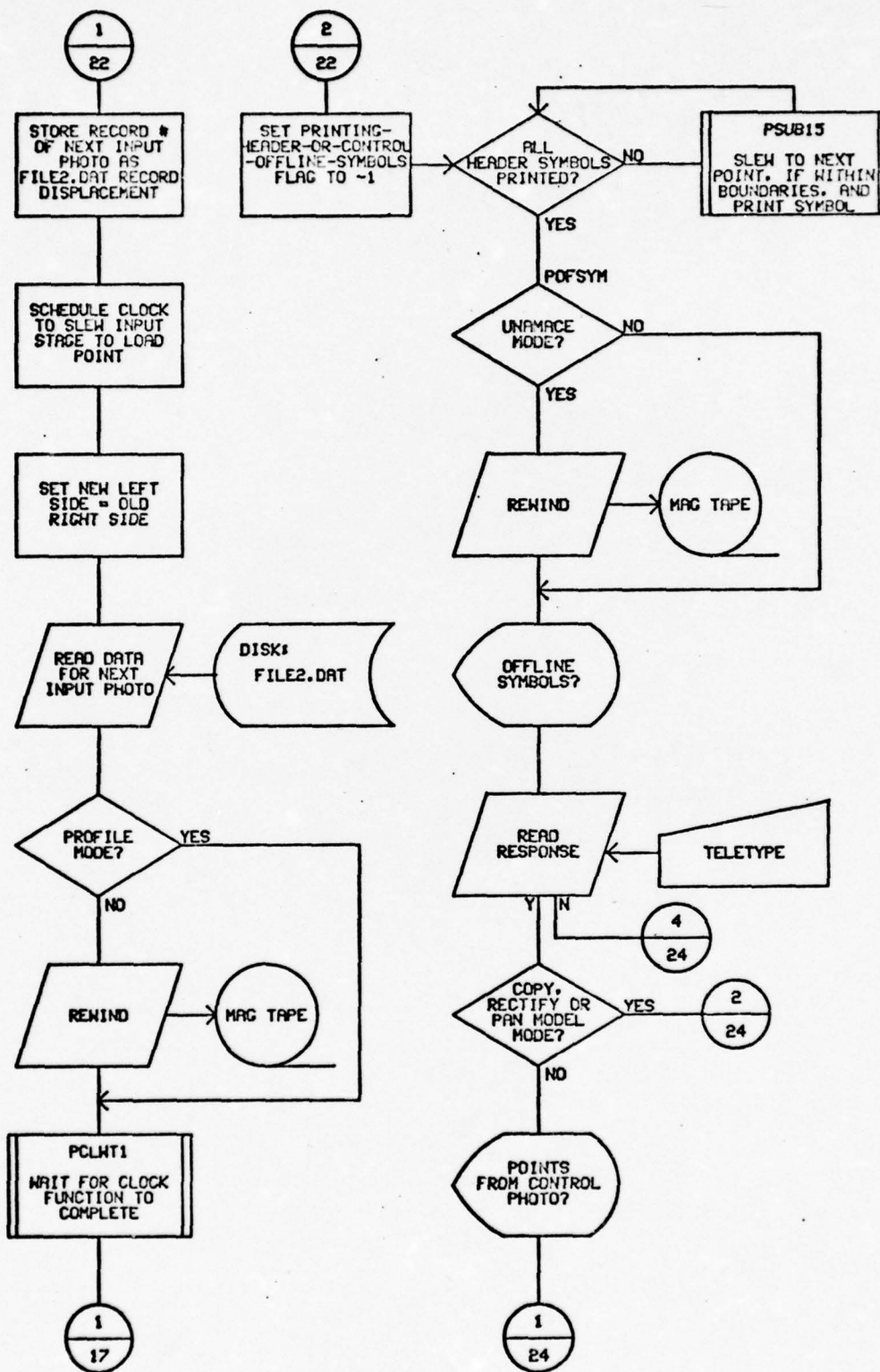


Figure 5-3 - Printing Symbols Flowchart Changes (1 of 5)

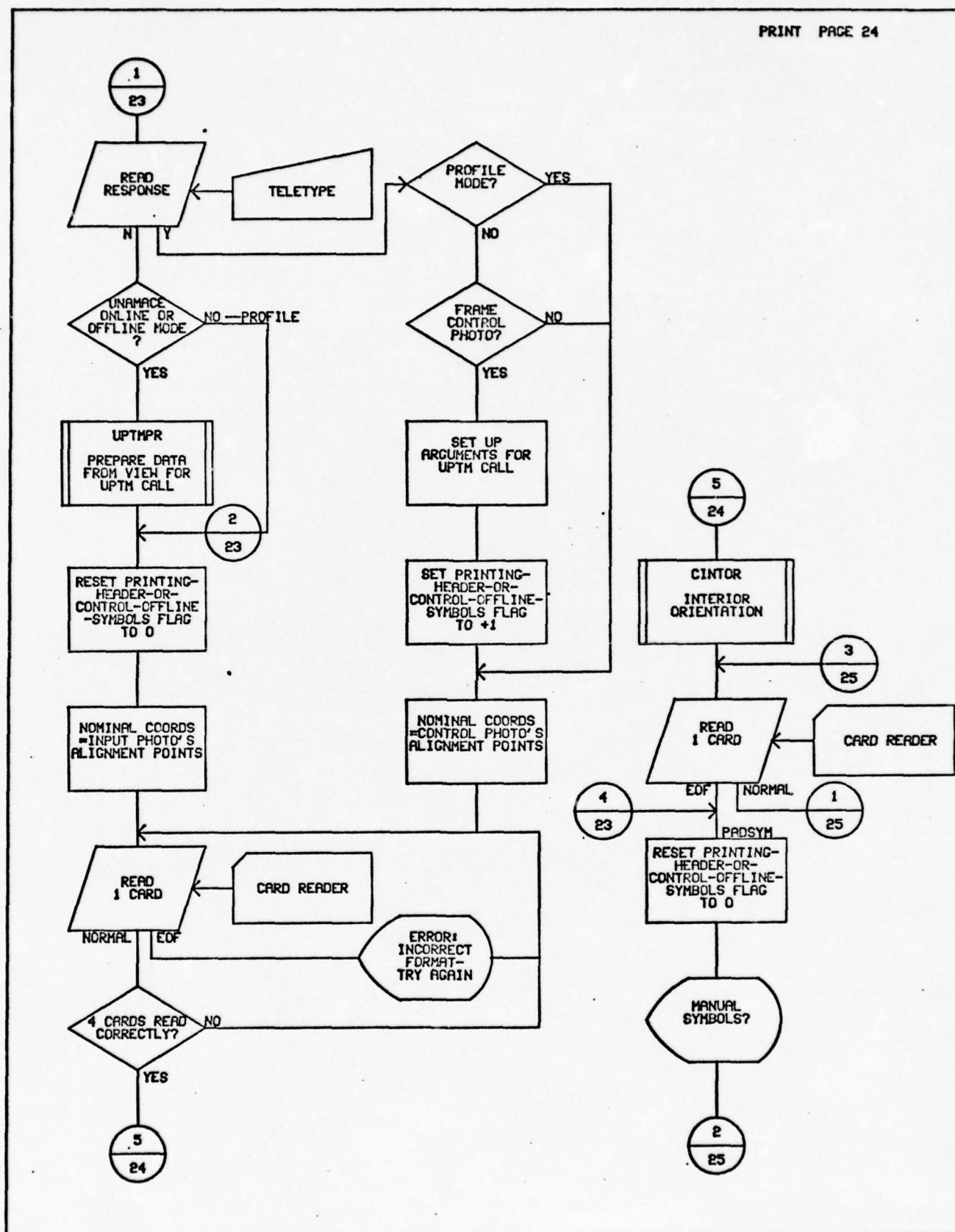


Figure 5-3 - Printing Symbols Flowchart Changes (2 of 5)

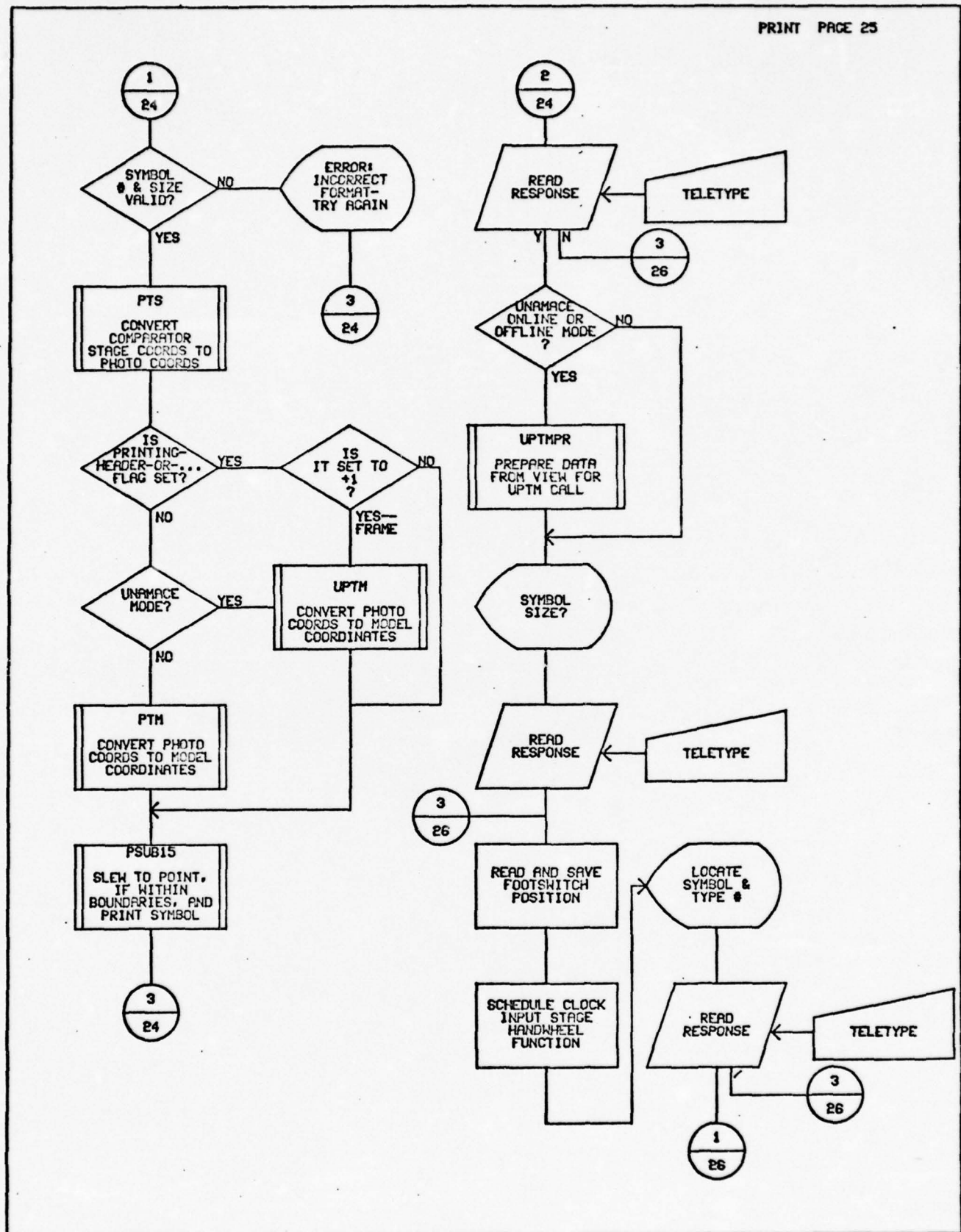


Figure 5-3 - Printing Symbols Flowchart Changes (3 of 5)

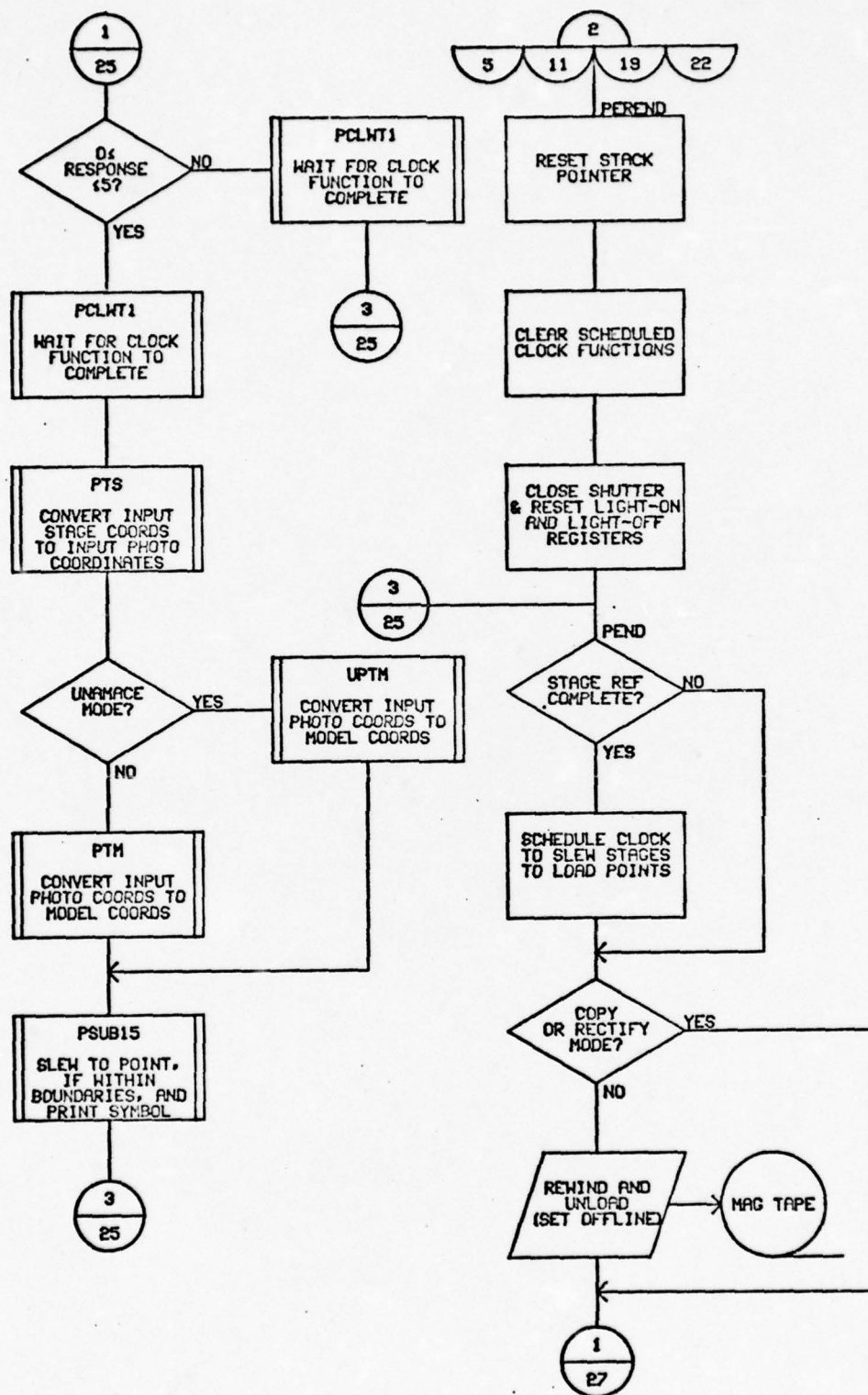


Figure 5-3 - Printing Symbols Flowchart Changes (4 of 5)

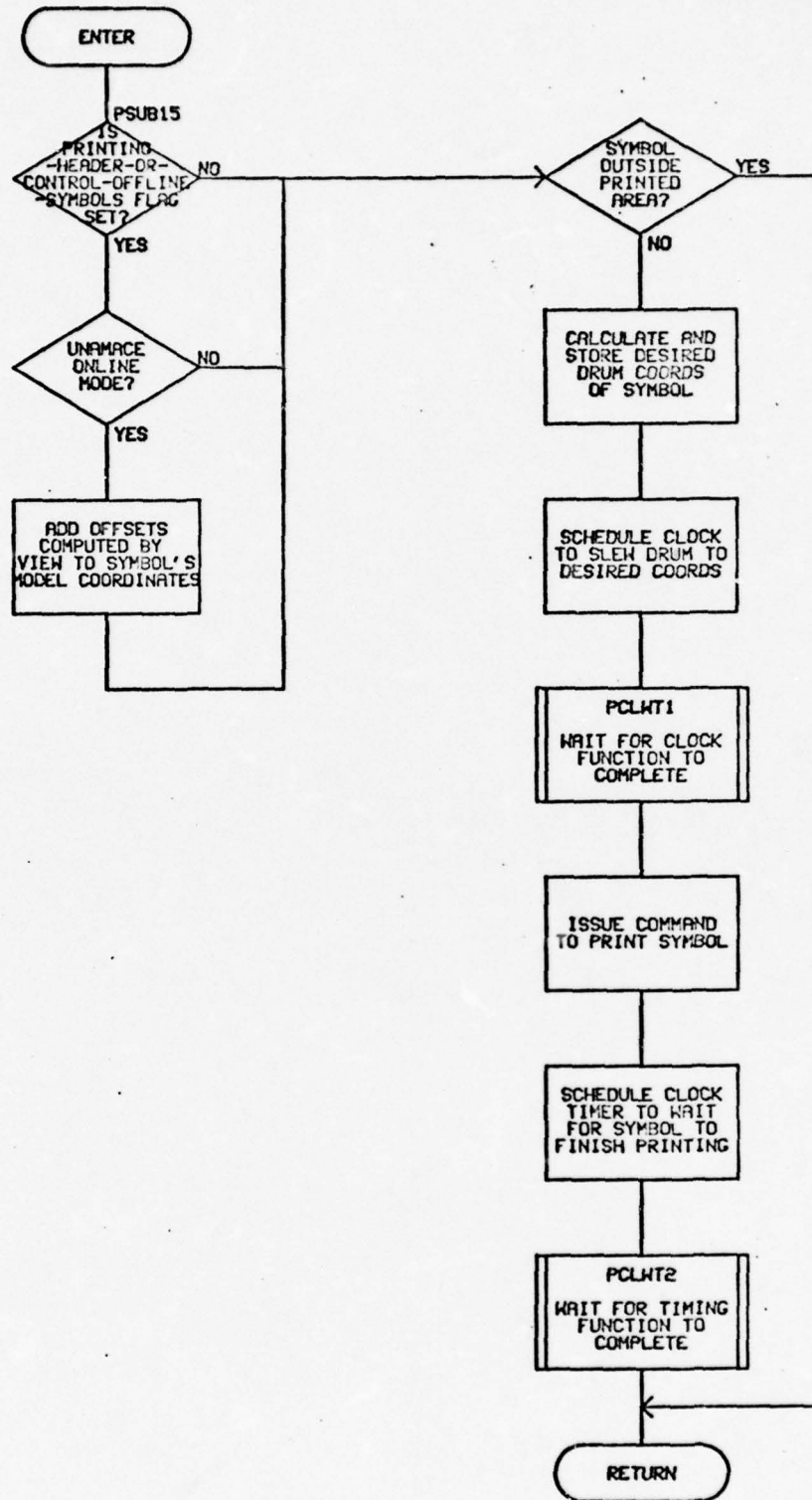


Figure 5-3 - Printing Symbols Flowchart Changes (5 of 5)

from each of the four possible sources. A new flag, the printing-header-or-control-offline-symbols flag, is set as follows to differentiate three conditions:

- 1 = header or control offline symbols are now being
 printed on the output photo
- 0 = header or control offline symbols are not now being
 printed on the output photo
- +1 = control offline symbols from a frame control photo
 are now being printed on the output photo

The flag is tested by the "print next symbol" subroutine (see page 5 of Figure 5-3). If the flag is non-zero and if the operating mode is UNAMACE ONLINE, the subroutine adds the symbol placement offsets computed by VIEW to the symbol's model coordinates. When input offline and manual symbols are being printed in UNAMACE ONLINE and OFFLINE modes, it is the modified UNAMACE photo-to-model routine that is called to obtain accurate results. As in the case of the VIEW program, the UPTMPR routine is first called to prepare the data from the viewer for the UPTM routine.

5.2 INPUTS/OUTPUTS

As part of the required program changes, small additions were made to two disk data files. The photo file, which transports information between the viewer and the printer, was one of the files enlarged. Recall that the photo file really consists of two interrelated data files whose mnemonics are FILE1.DAT and FILE2.DAT. Both were increased by four words per record in order to make room for the symbol placement offsets computed by VIEW for use by PRINT. Table 5-1 lists FILE1.DAT data as it now is stored. Note that the offsets have

Table 5-1 - Photo File (FILE1.DAT) Format (1 of 2)

<u>Item No.</u>	<u>Item</u>	<u>Length</u>	<u>Units</u>	<u>Data Type</u>
EACH RECORD - Word count = 115		(81 records total)		
1	ID from magnetic tape's header record	18 bytes		ASCII
Data for Output Photo -				
2	Output photo boundaries			
	Initial X model coordinate	2 words	μm	floating
	Final X model coordinate	2 words	μm	floating
	Initial Y model coordinate	2 words	μm	floating
	Final Y model coordinate	2 words	μm	floating
3	Print width index*	1 byte		Integer
4	Mode flag**	1 byte		
5	Inverse of output photo scale	2 words		floating
Data Unique to Input Photo -				
6	Input photo identification number	16 bytes	μm	ASCII
7	Actual input photo index point coordinates			
	x coordinate	2 words	μm	floating
	y1 coordinate	2 words	μm	floating
	y2 coordinate	2 words	μm	floating
8	Input photo's reference theta angle (center scan angle)	2 words	radians	floating
9	Input photo's focal length	2 words	μm	floating
10	Air refraction constants			
	K1	2 words	μm	floating
	K2	2 words	μm	floating
11	Image motion constant	2 words	μm	floating
12	Orientation elements			
	BX (also called XL)	2 words	μm	floating
	BY (also called YL)	2 words	μm	floating
	BZ (also called ZL)	2 words	μm	floating
	KAPPA	2 words	radians	floating
	OMEGA	2 words	radians	floating
	PHI	2 words	radians	floating
13	Transformation coefficients			
	a0	2 words	μm	floating
	a1	2 words	μm^0	floating
	a2	2 words	μm^0	floating
	a3	2 words	μm^{-1}	floating
	a4	2 words	μm^{-1}	floating
	a5	2 words	μm^{-1}	floating
	a6	2 words	μm^{-2}	floating
	a7	2 words	μm^{-2}	floating
	a8	2 words	μm^{-2}	floating
	a9	2 words	μm^{-2}	floating

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Table 5-1 - Photo File (FILE1.DAT) Format (2 of 2)

Item No.	Item	Length	Units	Data Type
	b0	2 words	μm	floating
	b1	2 words	μm^0	floating
	b2	2 words	μm^0	floating
	b3	2 words	μm^{-1}	floating
	b4	2 words	μm^{-1}	floating
	b5	2 words	μm^{-1}	floating
	b6	2 words	μm^{-2}	floating
	b7	2 words	μm^{-2}	floating
	b8	2 words	μm^{-2}	floating
	b9	2 words	μm^{-2}	floating
14	Symbol placement offsets			
	X model coordinate offset	2 words	μm	floating
	Y model coordinate offset	2 words	μm	floating
15	Link to FILE2.DAT record	1 word		integer
16	Right match line end point coordinates			
	Point 1's X model coordinate	2 words	μm	floating
	Point 2's X model coordinate	2 words	μm	floating
17	Intensity (calculated and stored by printer)	2 words		floating
18	Center line densities			
	Maximum	2 words		floating
	Minimum	2 words		floating
	Average	2 words		floating
19	Right match line average density	2 words		floating

*Print Width	Index	**Bit	=0	=1
1 mm	0	7	UNAMACE mode	Profile mode
2 mm	1	6	Online mode	Offline mode
4 mm	2	5	Orthophoto control	Frame photo control
8 mm	3	4	Frame photo no. 1	Frame photo no. 2
		3-1	Unused	
		0	Status = viewed	Status = viewed and printed

NOTES: If bit 7=1, then bit 6=0 and bit 5 =0.
Bit 4 is meaningful only if bit 5=1.

been inserted immediately after the transformation coefficients. Table 5-2 indicates data now stored in each record in FILE2.DAT.

Because the photo file was lengthened, the support program IFILES was modified to erase the longer records. For convenience, IFILES also was changed to initialize record 0 of FILE1.DAT. Record 0 holds nominal FILE1.DAT data and is used by the printer in RECTIFY and COPY modes.

The message file (MESFIL.DAT) was the other disk data file that was changed. Unlike the photo file, the message file was not enlarged in the sense that more space had to be allocated for it on the disk. Rather, the UPDATE program was used to add messages to the existing file. The messages are stored in records that have not been used until this time. All of the new messages pertain to scan alignment at the viewer and appear at the CRT terminal during the viewer's operation. The messages and their associated record numbers are as follows:

<u>Record Number</u>	<u>Message</u>
218	ALIGN CONTROL SCAN
219	ALIGN INPUT SCAN
220	WARNING: THE VIEWER UNIT MAY NEED TO BE ALIGNED
221	X Y
222	ALIGNMENT POINT OFFSETS:

Both the original photo file and the message file are discussed in detail in Section 3.4 of the Handbook for Replacement of Photographic Imagery Equipment, Volume I, System Description and Operating Procedures Instruction Manual.

Table 5-2 - Photo File (FILE2.DAT) Format

<u>Item No.</u>	<u>Item</u>	<u>Length</u>	<u>Units</u>	<u>Data Type</u>
EACH RECORD - Word count = 97		(240 records total)		
1 . . . 14	Same as items 6 - 19 in FILE1.DAT			
15	Left match line average density	2 words		floating

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5.3 LISTINGS

In total, six RPIE source modules were involved in the program changes made. They are INIT, CLOCK, COMMON, PRINT, VIEW, and IFILES. Because the complete listing of each of these source modules is long and because a source module listing can be produced readily at the RPIE system at any time, modified versions of the six modules are not listed in completion in this section. Instead, only the modifications are listed together with an explanation of how they affect the original listings. The explanations are found in comment lines that reference the original source listings (see Programming Documentation for Replacement of Photographic Imagery Equipment, Volume II) by giving the page and line number(s) where the change is occurring. Beyond referring to the location, the comment line indicates the nature of the change - deletion, insertion, or replacement. All changes are coded in the assembly language of the PDP11/45 computer.

Following is a table of contents for the remainder of this section. Brief, general statements are included to make the changes made in each module more comprehensible.

<u>Listing</u>	<u>Page</u>
1. INIT modifications	5-24
Symbol placement offsets added to printer's photo file data storage.	
2. CLOCK modifications	5-25
New viewer clock function added to wait for GO or SKIP button.	
	5-22

3. COMMON modifications

5-26

Record lengths changed in record blocks for disk photo file.

Symbol placement offsets added to viewer's photo file data storage.

FMTP routine changed to use viewer-computed data.
(FMTP is called by the UNAMACE photo-to-model routine, UPTM.)

New UPTMPR routine added to prepare viewer-computed data for UPTM call.

4. PRINT modifications

5-29

Changed to use symbol placement offsets in printing header, control offline symbols.

Changed to use viewer-computed data, when appropriate, in photo-to-model computation (UPTM).

Changed to check for frame control at the viewer.

5. VIEW modifications

5-32

Scan alignment capability added.

Changed to compute symbol placement offsets.

6. IFILES modifications

5-36

Record 0 of photo file now initialized for PRINT.

Record lengths changed in record blocks for disk photo file.

5-23

KB:<INIT. MOD

; FOLLOWING ARE THE MODIFICATIONS MADE TO INIT
; UNDER THE RPIE SYMBOL PLACEMENT ACCURACY CONTRACT

; CHANGE 1-17 TO

. GLOBL PPTR, PLBPTR, PIOVAL, PSEGL, PYCNT

; INSERT BETWEEN 1-49 AND 1-50

. GLOBL PXSOFF, PYSOFF

; INSERT BETWEEN 1-469 AND 1-470

PXSOFF: .FLT2 0

; X SYMBOL OFFSET

PYSOFF: .FLT2 0

; Y SYMBOL OFFSET

; DELETE 1-664

#

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KB: <CLOCK. MOD

; FOLLOWING ARE THE MODIFICATIONS MADE TO CLOCK
; UNDER THE RPIE SYMBOL PLACEMENT ACCURACY CONTRACT

; INSERT BETWEEN 1-44 AND 1-45
; GLOBL VCSGWT, VCGOSK

; INSERT BETWEEN 2-650 AND 2-651
VCSGWT= -V50S1-2

MOV VPNL, R1
BIC #177771, R1
MOV #0, R0

; VIEW WAIT FOR GO OR SKIP FUNCTION
; READ CURRENT STATUS OF GO
; AND SKIP BUTTONS

VCGOSK= -2

XOR R1, R0
BEQ V50S1I
MOV R0, VCGOSK
BR V50S1C

; CURRENT STATUS CHANGED?
; NO--CONTINUE WAIT
; YES--STORE BUTTON SELECTION AND
; END WAIT

#

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KB:COMMON. MOD

; FOLLOWING ARE THE MODIFICATIONS MADE TO COMMON
; UNDER THE RPIE SYMBOL PLACEMENT ACCURACY CONTRACT.

; INSERT BETWEEN 1-104 AND 1-105
; GLOBL VXSOFF, VYSOFF, UPTMPR
; CHANGE 1-386 TO
; .WORD 230. ; RECORD LENGTH (BYTES)
; CHANGE 1-393 TO
; .WORD 230. ; RECORD LENGTH (BYTES)
; CHANGE 1-407 TO
; .WORD 194. ; RECORD LENGTH (BYTES)
; CHANGE 1-414 TO
; .WORD 194. ; RECORD LENGTH (BYTES)
; CHANGE 1-455 TO
; .WORD 230. ; RECORD LENGTH (BYTES)
; CHANGE 1-459 TO
; .WORD 194. ; RECORD LENGTH (BYTES)
; CHANGE 1-463 TO
; .WORD 194. ; RECORD LENGTH (BYTES)
; INSERT BETWEEN 1-666 AND 1-667
PMGVEL: .FLT2 75. ; MAG VELOCITY CONTROL

; INSERT BETWEEN 2-158 AND 2-159
VXSOFF: .FLT2 0 ; X SYMBOL OFFSET
VYSOFF: .FLT2 0 ; Y SYMBOL OFFSET
; CHANGE FROM 2-209 THROUGH 2-234 TO
; OR
; ARG1=0 TO INDICATE THAT MTPS AND IPTAP SHOULD BE
; CALLED INSTEAD OF UMTPS
; ARG2=ADDR OF ORIENTATION ELEMENTS
; ARG3=ADDR OF MODEL SCALE OR 0 (NO EARTH CURVATURE CORRECTION)
; ARG4=ADDR OF AIR REFRACTION CONSTANTS OR 0 (NO AF CORRECTION)
; ARG5=ADDR OF REFERENCE THETA
; ARG6=ADDR OF FOCAL LENGTH
; ARG7=ADDR OF TEMPORARY STORAGE (4 WORDS)
; ARG8=ADDR OF TRANSFORMATION COEFFICIENTS
FMTP: MOV R5, -(SP) ; SAVE RETURN ADDRESS
TST (R5)+ ; INC TO ARGUMENTS
MOV 4(R5), R2 ; R2=ADDR OF ARG1ST
TST (R2) ; ARG1=0 IN ARG1ST?
BEQ 16\$; YES--USE MTPS CALL
MOV #5+2, R0 ; NO--USE UMTPS CALL
MOV #5, R1
14\$: MOV -(R0), -(SP) ; SAVE VOLATILE DATA
SOB R1, 14\$
MOV (R5)+, (R0)+ ; STORE ARGUMENTS FOR UMTPS
MOV (R2)+, (R0)+
MOV (R2)+, (R0)+
MOV (R2)+, (R0)+
MOV (R5), (R0)
JSR R5, UMTPS ; UNAMACE MODEL-TO-PHOTO SUBR
1\$: .WORD 0
2\$: .WORD 0
3\$: .WORD 0
4\$: .WORD 0
5\$: .WORD 0
MOV #1\$, R0

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```

15$: MOV    #5, R1
      MOV    (SP)+, (R0)+      ; RESTORE VOLATILE DATA
      SOB    R1, 15$
      MOV    (SP)+, R5         ; RESTORE RETURN ADDRESS
      RTS    R5                ; RETURN

16$: MOV    #12$+2, R0
      MOV    #7, R1

17$: MOV    -(R0), -(SP)       ; SAVE VOLATILE DATA
      SOB    R1, 17$
      MOV    13$, -(SP)
      MOV    (R5)+, (R0)+      ; STORE ARGUMENTS FOR MTPS
      TST    (R2)+
      MOV    #6, R1

18$: MOV    (R2)+, (R0)+
      SOB    R1, 18$
      MOV    (R2), 13$
      MOV    (R5), R5
      JSR    R5, MTPS          ; MODEL-TO-PHOTO SUBR

6$:   .WORD  0
7$:   .WORD  0
8$:   .WORD  0
9$:   .WORD  0
10$:  .WORD  0
11$:  .WORD  0
12$:  .WORD  0

                                     ; ON RETURN AC2=PHOTO X,
                                     ; AC3=PHOTO Y
                                     ; IDEALIZED-PHOTO-TO-ACTUAL
13$:  JSR    R5, IPTAP          ; -PHOTO SUBR
      .WORD  0
      MOV    (SP)+, 13$
      MOV    #6$, R0
      MOV    #7, R1
      BR     15$

; PREPARE-FOR-UPTM SUBROUTINE (USED TO STORE 2 FOCAL LENGTHS
; FROM ONE AND COMPUTE ORIENTATION ELEMENT MATRIX FROM ANGLES)
; ARG1=ADDR OF FOCAL LENGTH
; ARG2=ADDR OF STORAGE FOR 2 FOCAL LENGTHS (4 WORDS)
; ARG3=ADDR OF ORIENTATION ELEMENT ANGLES (OMEGA)
; ARG4=ADDR OF STORAGE FOR MATRIX (36 WORDS)
UPTMPR: LDF    @ (R5)+, AC0      ; STORE FOCAL LENGTH AS X AND Y
      MOV    (R5)+, R0          ; FOCAL LENGTHS TO MEET
      STF    AC0, (R0)+        ; UPTM ROUTINE'S ARGUMENT
      STF    AC0, (R0)         ; REQUIREMENTS
      MOV    SP, R1
      MOV    #3, R2
      MOV    (R5)+, R4
      LDF    (R4), AC0
      ADDF    @ (R5), AC0        ; ADD REF THETA TO OMEGA
      STF    AC0, (R4)+
1$:   TRAP    18.                ; COMPUTE TRIG FUNCTIONS AND
      STF    AC0, -(SP)         ; STORE ON STACK SO THEY END
      TRAP    16.                ; UP IN FOLLOWING ORDER:
      STF    AC0, -(SP)         ; SK, CK, SW, CW, SP, CP
      CMP    -(R4), -(R4)
      SOB    R2, 1$
      LDF    8. (R4), AC0
      SUBF    @ (R5)+, AC0
      STF    AC0, 8. (R4)
      MOV    SP, R0
      MOV    (R5)+, R2          ; COMPUTE ORIENTATION MATRIX
                                     ; ELEMENTS AND STORE IN TEMPORARY
                                     ; STORAGE--
      LDF    (R0)+, AC0         ; SK
      LDF    (R0)+, AC1         ; CK
      MULF    -(R1), AC1        ; CPCK
      STF    AC1, AC5
      MULF    (R0), AC0         ; SWSK

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STF	AC0, AC4	
MULF	-(R1), AC0	; SPSWSK
SUBF	AC0, AC1	; CPCK-SPSWSK
STF	AC1, (R2)+	; =A11
LDF	(R1)+, AC0	; SP
MULF	(R0), AC0	; SWSP
MULF	-(R0), AC0	; CKSWSP
LDF	(SP), AC1	; SK
MULF	(R1), AC1	; CPSK
ADDF	AC1, AC0	; CPSK+CKSWSP
STF	AC0, (R2)+	; =A12
LDF	-(R1), AC0	; SP
MULF	-(R1), AC0	; CWSP
NEGF	AC0	; -CWSP
STF	AC0, (R2)+	; =A13
LDF	(R1), AC0	; CW
MULF	(SP), AC0	; SKCW
NEGF	AC0	; -SKCW
STF	AC0, (R2)+	; =A21
LDF	(R1)+, AC0	; CW
MULF	(R0), AC0	; CKCW
STF	AC0, (R2)+	; =A22
LDF	(R0)+, AC1	; CK
LDF	(R0)+, AC0	; SW
STF	AC0, (R2)+	; =A23
MULF	(R1)+, AC1	; SPCK
LDF	(R1), AC2	; CP
MULF	AC4, AC2	; SKSWCP
ADDF	AC2, AC1	; SKSWCP+SPCK
STF	AC1, (R2)+	; =A31
MULF	AC5, AC0	; CKCPSW
LDF	(SP), AC1	; SK
MULF	-(R1), AC1	; SPSK
SUBF	AC0, AC1	; SPSK-CKCPSW
STF	AC1, (R2)+	; =A32
LDF	(R0), AC0	; CW
ADD	#24, SP	
MULF	(SP)+, AC0	; CPCW
STF	AC0, (R2)+	; =A33
RTS	R5	; RETURN

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KB: <PRINT. MOD

; FOLLOWING ARE THE MODIFICATIONS MADE TO PRINT
; UNDER THE RPIE SYMBOL PLACEMENT ACCURACY CONTRACT

; INSERT BETWEEN 1-53 AND 1-54
; GLOBL PXSOFF, PYSOFF, UPTMPR, VP2OFF
; INSERT BETWEEN 1-348 AND 1-349
PTEMP: . = +64
; INSERT BETWEEN 1-776 AND 1-777
TST #0 ; PRINTING A HEADER OR CONTROL
PHCSYM= -2 ; OFFLINE SYMBOL?
BEQ 1\$; NO--SKIP
TSTB PMODE ; YES--UNAMACE ONLINE MODE?
BLE 1\$; NO--PROFILE, P-M, RECT, OR
; COPY
BITB #100, PMODE
BNE 1\$; NO--UNAMACE OFFLINE
ADDF PXSOFF, AC0 ; YES--ADD OFFSETS TO SYMBOL'S
ADDF PYSOFF, AC1 ; XM, YM TO CORRECT FOR VIEWER

1\$:
; CHANGE 1-1011 TO
BNE PERR4
; CHANGE 1-1483 TO
ADDF PXYRBF+190, AC0 ; LEFT AVG DENSITY
; CHANGE 1-1488 TO
5\$: MOV #PXYRBF+170, R5 ; ADDR OF NEXT INTENSITY

; INSERT BETWEEN 2-322 AND 2-323
MOV #-1, PHCSYM ; SET PRINTING-HEADER-OR-
; CONTROL-OFFLINE-SYMBOLS
; FLAG

; DELETE 2-328 AND 2-329
; CHANGE 2-330 TO
POFSYM: TSTB PSMODE ; UNAMACE MODE?
; CHANGE 2-331 TO
BGE 8\$; NO--SKIP
; CHANGE 2-332 TO
JSR R5, PRWSUB ; YES--REWIND TAPE
; CHANGE 2-335 TO
BR 4\$; NO
; CHANGE 2-337 TO
ADD #PFX1+8, R5
; CHANGE 2-341 TO
BLT 9\$; P-M UNAMACE

; INSERT BETWEEN 2-354 AND 2-355
9\$: CLR PHCSYM ; RESET PRINTING-HEADER-OR-
; CONTROL-OFFLINE-SYMBOLS
; FLAG

; CHANGE 2-355 TO
BR P35
; INSERT BETWEEN 2-355 AND 2-356
4\$: BR PADSYM
10\$: TSTB PMODE ; PROFILE MODE?
BLT 3\$; YES--USE INPUT PHOTO FIDUCIALS
; NO, UNAMACE ONLINE OR OFFLINE

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JSR	R5, UPTMPR	; PREPARE ARGUMENTS FOR UPTM
.WORD	PF	; STORE INPUT PHOTO'S FOCAL LENGTH
		; TWICE
.WORD	PTMP+44	; IN THIS TEMPORARY STORAGE
.WORD	PW0	; COMPUTE INPUT PHOTO'S ORIENTATION
.WORD	PTHTAR	; ELEMENTS MATRIX
.WORD	PTMP	; AND STORE IN THIS TEMP STORAGE
BR	3\$; USE INPUT PHOTO FIDUCIALS
; CHANGE 2-358 TO		
BR	10\$; NO, INPUT PHOTO
; INSERT BETWEEN 2-359 AND 2-360		
TSTB	Pmode	; PROFILE MODE?
BLT	P35	; YES
BITB	#40, Pmode	; NO--FRAME CONTROL?
BEQ	P35	; NO
MOV	#PFX1, R5	; YES
BITB	#20, Pmode	; PHOTO 1 ON TAPE?
BEQ	11\$; YES
ADD	#VP2OFF, R5	; NO--PHOTO 2
		; SETUP FOR UPTM--
11\$:	MOV R5, PFOC	; FOCAL LENGTH ADDR
	ADD #60, R5	; CAMERA STATION
	MOV R5, PCAMST	; COORDS ADDR
	ADD #12, R5	; ORIENTATION ELEMENTS
	MOV R5, PORIEN	; MATRIX ADDR
	SUB #64, R5	; R5=FIDUCIALS' ADDR
	NEG PHCSYM	; SET PRINTING-HEADER-OR
		; CONTROL-OFFLINE-SYMBOLS
		; FLAG POSITIVE
; CHANGE 2-360 TO		
P35:	MOV R5, 15\$; STORE ADDR OF NOM COORDS
; CHANGE 2-380 TO		
TST	PHCSYM	; CONTROL ORTHOPHOTO?
; CHANGE 2-381 TO		
BLT	4\$; YES--ALREADY HAVE MODEL COORDS
; INSERT BETWEEN 2-381 AND 2-382		
BEQ	19\$; NO--INPUT
JSR	R5, PSU19A	; NO, CONTROL FRAME--CONVERT
BR	16\$; FROM PHOTO TO MODEL
BR	4\$	
19\$:		
; INSERT AFTER 2-405'S PADSYM:		
CLR	PHCSYM	; RESET PRINTING-HEADER-OR-
		; CONTROL-OFFLINE-SYMBOLS
		; FLAG
; INSERT BETWEEN 2-407 AND 2-408		
TSTB	Pmode	; PROFILE, P-M, COPY, OR
		; RECTIFY?
BLE	1\$; YES--SKIP
		; NO, UNAMAGE ONLINE OR OFFLINE
JSR	R5, UPTMPR	; PREPARE ARGUMENTS FOR UPTM
.WORD	PF	; STORE INPUT PHOTO'S FOCAL LENGTH
		; TWICE
.WORD	PTMP+44	; IN THIS TEMPORARY STORAGE
.WORD	PW0	; COMPUTE INPUT PHOTO'S ORIENTATION
.WORD	PTHTAR	; ELEMENTS MATRIX
.WORD	PTMP	; AND STORE IN THIS TEMP STORAGE
; CHANGE 2-418 TO		
JSR	R5, PTTYR	
; CHANGE 2-437 TO		
BR	4\$; ERROR
; INSERT BETWEEN 2-441 AND 2-442		
2\$:	JSR R5, PCLWT1	; WAIT FOR HANDWHEELS TO COMPLETE
	BR 3\$; IGNORE BECAUSE OF ERROR
4\$:	TST (SP)+	
	BR 3\$	

COPY AVAILABLE TO DDC DOES NOT
PERMIT FULLY LEGIBLE PRODUCTION

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; CHANGE 2-701 TO
    BLT      P33      ; PROFILE
; INSERT BETWEEN 2-701 AND 2-702
    BGT      P34      ; UNAMACE ONLINE OR OFFLINE
; CHANGE 2-703 TO
    BGE      P33      ; RECT/COPY
; CHANGE 2-704 TO
PSU19A: MOV      #PXMR, R1
; CHANGE 2-705 TO
    MOV      R1, R0
; INSERT BETWEEN 2-708 AND 2-709
P34:   JSR      R5, UPTM      ; UNAMACE PHOTO-TO-MODEL USING
    BR       2$             ; ALL DATA FROM VIEWER
    .WORD    PXMR           ; PAN PHOTO COORDS PNTR
    .WORD    PTEMP+44       ; FOCAL LENGTH PNTR
    .WORD    PBX0           ; EXPOSURE STATION PNTR
    .WORD    PTEMP          ; ORIENTATION MATRIX PNTR
    .WORD    PZST           ; ESTIMATED STARTING ELEV PNTR
    .WORD    PARG1          ; PNTR TO ELEV SUBR'S ARG LIST
    .WORD    3$             ; PNTR TO FMTP SUBR'S ARG LIST
    .WORD    PXMR           ; MODEL COORDS PNTR
2$:    TST      R0           ; INDETERMINATE SOLUTION?
    BNE      P25            ; YES
    BR       P26            ; NO
3$:    .WORD    0           ; FLAG TELLING FMTP TO CALL
    .WORD    PBX0           ; MTPS AND IPTAP
    .WORD    0             ; EXPOSURE STATION PNTR
    .WORD    0             ; NO EARTH CURVATURE
    .WORD    0             ; NO AIR REFRACTION CORRECTION
    .WORD    PTHTR         ; REFERENCE THETA POINTER
    .WORD    PF            ; FOCAL LENGTH POINTER
    .WORD    PTEMP+54       ; PHOTO COORDS TEMP STORAGE
    .WORD    PTC           ; TRANSFORMATION COEFFICIENTS
                                ; POINTER
; CHANGE 2-709 TO
P33:   JSR      R5, PTM      ; NO--TRANSFORM COORDS INTO

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KB:VIEW.MOD

; FOLLOWING ARE THE MODIFICATIONS MADE TO VIEW
; UNDER THE RPIE SYMBOL PLACEMENT ACCURACY CONTRACT

```
; INSERT BETWEEN 1-61 AND 1-62
. GLOBL UPTMPR, VXSOFF, VYSOFF
. GLOBL VCSGWT, VCGOSK
; INSERT BETWEEN 1-827 AND 1-828
CLR VSCALD ; RESET SCAN ALIGNED FLAG
; INSERT BETWEEN 1-841 AND 1-842
JSR PC, VALSC ; ALIGN SCAN
; INSERT BETWEEN 1-855 AND 1-856
JSR PC, VALSC ; ALIGN SCAN (IF NOT ALIGNED)
; INSERT BETWEEN 1-856 AND 1-857
JSR PC, VALSC ; ALIGN SCAN (IF NOT ALIGNED)
; INSERT BETWEEN 1-857 AND 1-858
JSR PC, VALSC ; ALIGN SCAN (IF NOT ALIGNED)

; INSERT BETWEEN 2-120 AND 2-121
CLR VSCALD ; RESET SCAN ALIGNED FLAG
; INSERT BETWEEN 2-241 AND 2-242
JSR PC, VALSC ; ALIGN SCAN
; INSERT BETWEEN 2-257 AND 2-258
JSR PC, VALSC ; ALIGN SCAN (IF NOT ALIGNED)
; INSERT BETWEEN 2-258 AND 2-259
JSR PC, VALSC ; ALIGN SCAN (IF NOT ALIGNED)
; INSERT BETWEEN 2-259 AND 2-260
JSR PC, VALSC ; ALIGN SCAN (IF NOT ALIGNED)
; CHANGE 2-407 TO
BGE 12$ ; NO, UNAMACE ONLINE
; INSERT BETWEEN 2-409 AND 2-410
12$: MOV #VPM, R0 ; SAVE MEASURED ALIGNMENT POINT
MOV #VPMR, R1 ; INPUT PHOTO AND MODEL COORDS
MOV #VPP, R2 ; FOR LATER COMPUTATION OF
MOV #VPPA, R3 ; SYMBOL PLACEMENT OFFSETS
MOV #4, R4 ; STORE POINT'S--
13$: LDF (R0)+, AC0 ; XM
STF AC0, (R1)+
LDF (R0)+, AC0 ; YM
STF AC0, (R1)+
TSTF (R0)+ ; (SKIP EM)
LDF (R2)+, AC0 ; XP
STF AC0, (R3)+
LDF (R2)+, AC0 ; YP
STF AC0, (R3)+
SOB R4, 13$ ; REPEAT FOR NEXT ALIGNMENT PT
; CHANGE 2-1010 TO
BEQ VSMBL ; NO, UNAMACE ONLINE--COMPUTE
; SYMBOL PLACEMENT OFFSETS
; DELETE 2-1011
; INSERT AFTER 2-1061
VSMBL: JSR R5, UPTMPR ; BEGIN COMPUTATION OF SYMBOL
; PLACEMENT OFFSETS--
; FIRST, PREPARE ARGUMENTS FOR
; UPTM ROUTINE
; STORE INPUT PHOTO'S FOCAL
; LENGTH TWICE
; IN THIS TEMPORARY STORAGE
; COMPUTE INPUT PHOTO'S ORIENTATION
; ELEMENTS MATRIX
; AND STORE IN THIS TEMP STORAGE
; THEN, COMPUTE OFFSETS BASED ON
```

COPY AVAILABLE TO DDC DOES NOT
PERMIT FULLY LEGIBLE PRODUCTION

	CLRF	AC2	; SAVED ALIGNMENT PT MEASUREMENTS
	CLRF	AC3	; STORAGE FOR SUM OF XM DIFFERENCE
	MOV	#VPMR, R0	; STORAGE FOR SUM OF YM DIFFERENCE
	MOV	#VPPR, R1	; LINK TO ALIGNMENT PT MODEL COORDS
	CLR	R2	; LINK TO ALIGNMENT PT PHOTO COORDS
	MOV	#4, R3	; GOOD PT COUNTER
	MOV	#VTEMP+44, R4	; ALIGNMENT PT COUNTER
	MOV	#60, VNALPT	; LINK TO TEMP STORAGE
			; INIT ALIGN PT # FOR OFFSET
			; DISPLAY
	JSR	R5, VCDS	; "ALIGNMENT POINT OFFSETS:"
	. WORD	222	
	JSR	R5, VCDS	; " X Y"
	. WORD	221	
			; GET NEXT ALIGNMENT PT'S PAN
			; PHOTO COORDS--
2\$:	LDF	(R1)+, AC1	; XP
	LDF	(R1)+, AC0	; YP
	STF	AC1, (R4)+	
	STF	AC0, (R4)+	
	INCB	VNALPT	; INC ALIGN PT # FOR OFFSET
			; DISPLAY
	JSR	R5, CRSAV	; SAVE REGISTERS
	JSR	R5, UPTM	; FORTRAN UNAMACE PHOTO TO
			; MODEL ROUTINE--COMPUTES MODEL
			; COORDS CORRESPONDING TO PHOTO
			; COORDS
	BR	3\$	
	. WORD	VTEMP+44	; PAN PHOTO COORDS PNTR
	. WORD	VTEMP+60	; FOCAL LENGTH PNTR
	. WORD	VEX	; EXPOSURE STATION PNTR
	. WORD	VTEMP	; ORIENTATION MATRIX PNTR
	. WORD	VZST	; ESTIMATED STARTING ELEV PNTR
	. WORD	VELARG	; PNTR TO ELEV SUBR'S ARG LIST
	. WORD	1\$; PNTR TO FMTF SUBR'S ARG LIST
	. WORD	VTEMP+44	; MODEL COORDS PNTR
3\$:	TST	R0	; INDETERMINATE SOLUTION?
	BNE	4\$; YES, POINT IS OUT OF RANGE
			; --SKIP
	JSR	R5, CRRES	; NO--RESTORE REGISTERS
	INC	R2	; INCREMENT GOOD PT COUNTER
	LDF	(R4), AC1	
	LDF	-(R4), AC0	
	SUBF	(R0)+, AC0	; PT'S XM OFFSET=COMPUTED XM
			; OF ALIGN PT-MEASURED XM
			; OF ALIGN PT
	SUBF	(R0)+, AC1	; PT'S YM OFFSET=COMPUTED YM
			; OF ALIGN PT-MEASURED YM
			; OF ALIGN PT
			; DISPLAY THESE OFFSETS
	JSR	R5, CRSAV	
	MOV	#VOIARG, R1	
	STF	AC1, -(SP)	
	STF	AC0, -(SP)	
	MOV	SP, (R1)	
	MOV	#0, R0	
VNALPT=-	2		
	JSR	R5, VCDS	
	. WORD	95	
	JSR	R5, VCD2VL	
	. WORD	4	
	ADD	#8, SP	
	JSR	R5, CRRES	
	ADDF	AC0, AC2	; ADD THIS PT'S OFFSETS TO
	ADDF	AC1, AC3	; STORED SUMS OF XM, YM DIFF
	SUB	R3, 2\$; REPEAT FOR NEXT ALIGNMENT PT
7\$:	LDCIF	R2, AC0	; AT LEAST ONE GOOD POINT?

```

BNE 5$ ;YES
CLRF AC2 ;NO--SET AVERAGE MODEL COORD
CLRF AC3 ;OFFSETS TO ZERO (NO SYMBOL
BR 6$ ;PLACEMENT CORRECTIONS)
4$: JSR R5, CRRES ;RESTORE REGISTERS
TSTF -(R4)
SOB R3, 2$ ;REPEAT FOR NEXT ALIGNMENT PT
BR 7$
5$: DIVF AC0, AC2 ;COMPUTE AVERAGE MODEL COORD
DIVF AC0, AC3 ;OFFSETS AND STORE AS SYMBOL
6$: STF AC2, VXSOFF ;PLACEMENT CORRECTIONS
STF AC3, VYSOFF
ABSF AC2 ;IF AN OFFSET IS LARGER
CMPF F50, AC2 ;THAN 50 MICRONS, WARN THE
CFCC ;OPERATOR ABOUT VIEWER ALIGNMENT
BLT 8$
ABSF AC3
CMPF F50, AC3
CFCC
BGE 9$
8$: JSR R5, VCDS ;"WARNING: THE VIEWER UNIT MAY
WORD 220. ;NEED TO BE ALIGNED"
9$: JMP VRESET
1$: WORD 0 ;FLAG TELLING FMTP TO CALL
;MTPS AND IPTAP
WORD VBX ;EXPOSURE STATION PNTR
WORD 0 ;NO EARTH CURVATURE
WORD 0 ;NO AIR REFRACTION CORRECTION
WORD VHTAR ;REFERENCE THETA PNTR
WORD VF ;FOCAL LENGTH PNTR
WORD VTEMP+70 ;PHOTO COORDS TEMP STORAGE
WORD VTRANC ;TRANSFORMATION COEFFICIENTS PNTR

;CHANGE 5-489 TO
VIPTM1: MOV #60, VINCNT ;INIT INDEX PT # TO 0
;DELETE 5-490
;INSERT BETWEEN 5-516 AND 5-517
JSR R5, VCDS ;READ "MEASURE INDEX POINT
WORD 104. ;0" MESSAGE
;CHANGE 5-517 TO
INC #0 ;INCREMENT
VINCNT= -2 ;INDEX PT #,
;INSERT BETWEEN 5-517 AND 5-518
MOVB VINCNT, VMESEF+22. ;STORE IT IN
;INSERT BETWEEN 5-534 AND 5-535
VALSC: TST #0 ;ALIGN SCAN SUBROUTINE
VSCALD= -2 ;IS SCAN ALREADY ALIGNED?
BNE 4$ ;YES--SKIP
JSR R5, CRSAV ;NO--SAVE REGISTERS
BIT #4, R5 ;CONTROL STAGE?
BEQ 5$ ;NO--INPUT STAGE
JSR R5, VCDS ;YES--"ALIGN CONTROL SCAN"
WORD 218.
1$: JSR R5, VALSCS
BR 7$ ;SKIP BUTTON
MOV #VSCGEN, R2 ;GO BUTTON
MOV #VSCALD, R1
BIT #4, R5 ;CONTROL STAGE?
BEQ 8$ ;NO--INPUT STAGE
MOV #50315, (R2) ;YES--SCAN SIZE=1MM
MOV #140632, (R2) ;SET BEAM CURRENT EQUIVALENTLY
JSR R5, VALSCS
DEC (R1) ;SKIP BUTTON--INSURE SCAN
;ALIGNED FLAG IS RESET

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MOV      #140000, (R2)      ; ZERO BEAM CURRENT
MOV      #53777, (R2)      ; SET SCAN SIZE TO MAX
3$: INC   (R1)               ; SET SCAN ALIGNED FLAG
7$: JSR   R5, CRRES         ; RESTORE REGISTERS
4$: RTS   PC                ; RETURN
5$: JSR   R5, VCD5          ; "ALIGN INPUT SCAN"
      .WORD 219.
      BR    1$
8$: MOV   #10315, (R2)      ; SCAN SIZE=1MM
      MOV   #130632, (R2)   ; SET BEAM CURRENT EQUIVALENTLY
      JSR   R5, VALSCS
      DEC   (R1)            ; SKIP BUTTON--INSURE SCAN
                                ; ALIGNED FLAG IS RESET
      MOV   #130000, (R2)   ; ZERO BEAM CURRENT
      MOV   #13777, (R2)    ; SET SCAN SIZE TO MAX
      BR    3$
VALSCS: CMP   #64, VINCNT   ; ALIGN SCAN SUB-SUBROUTINE
      BEQ   6$              ; 4TH INDEX PT?
      MOV   #VCGOSK, R0     ; YES--FORCE A GO BUTTON
      MOV   VPNL, (R0)      ; NO--ALLOW GO OR SKIP
      BIC   #177771, (R0)   ; STORE STATUS OF GO AND SKIP
      MOV   #VCSGWT, V50S1  ; BUTTONS FOR CLOCK
      JSR   R5, VCLWT1      ; SCHEDULE WAIT FOR GO OR SKIP
      BIT   #2, (R0)        ; CLOCK FUNCTION
      BNE   9$              ; SKIP BUTTON?
      TST   (R5)+           ; YES
      RTS   R5              ; NO--GO BUTTON
6$:      JSR   R5, VGOWT     ; RETURN
      BR    2$              ; WAIT FOR GO BUTTON SUBR
2$:      BR    2$

; INSERT BETWEEN 6-301 AND 6-302
VPPA:    . = . +40          ; SAVED ALIGNMENT POINT INPUT
                                ; PHOTO COORDS
VPMR:    . = . +40          ; SAVED ALIGNMENT POINT MODEL
                                ; COORDS
                                ; (UNAMACE ONLINE ONLY)

; INSERT BETWEEN 6-325 AND 6-326
      .FLT2 0, 0, 0, 0, 0, 0 ; AND FOR (UNAMACE ONLINE ONLY)
      .FLT2 0, 0, 0, 0      ; PHOTO COORDS, MODEL COORDS, AND
                                ; FOCAL LENGTHS DURING COMPU-
                                ; TATION OF SYMBOL PLACEMENT
                                ; OFFSETS

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KB: < IFILES. MOD

; FOLLOWING ARE THE MODIFICATIONS MADE TO IFILES
; UNDER THE RPIE SYMBOL PLACEMENT ACCURACY CONTRACT

; INSERT BETWEEN 1-25 AND 1-26

; RECORD 0:

PVCPID: . ASCII /000000000000000000/ ; CONTROL PHOTO ID #
PXMO: . FLT2 0 ; MODEL COORDS OF ENTIRE
PXM: . FLT2 0 ; OVERLAP AREA TO BE PRINTED
PYMO: . FLT2 0
PYM: . FLT2 0
PWINDX: . BYTE 3 ; INDEX TO PRINT WIDTH(0,1,2,3)
PMODE: . BYTE 0 ; 0=RECT; 1=UNAMACE; 21=PROFILE
POPSC: . FLT2 100000. ; OUTPUT PHOTO SCALING
; =MODEL DISTANCE/PHOTO DISTANCE
PIPID: . ASCII /000000000000000000/ ; INPUT PHOTO ID #
PIOX1: . FLT2 88900. ; INTERIOR ORIENTATION ELEMENTS
PIOY1: . FLT2 -100000.
PIOY2: . FLT2 100000.
PTHTAR: . FLT2 0 ; THETA REF
PF: . FLT2 500000. ; FOCAL LENGTH
PK1: . FLT2 0
PK2: . FLT2 0
PKIMC: . FLT2 0
PBX0: . FLT2 0
PBY0: . FLT2 0
PBZ0: . FLT2 500000.
PK0: . FLT2 0
PW0: . FLT2 0
PP0: . FLT2 0
PTC: . =. +80. ; TRANSFORMATION COEFFICIENTS
PXSOFF: . FLT2 0 ; X SYMBOL OFFSET
PYSOFF: . FLT2 0 ; Y SYMBOL OFFSET
PNXTIP: . WORD -1 ; POINTER TO NEXT INPUT PHOTO
PVXM3: . FLT2 0
PVXM4: . FLT2 0
PINTNS: . FLT2 3.5 ; INTENSITY FOR CURRENT PHOTO
PCDMAX: . FLT2 0 ; CENTER LINE
PCDMIN: . FLT2 0 ; DENSITY INFORMATION
PCDAVG: . FLT2 0
PRDAVG: . FLT2 0

; RECORDS 1-80:

; CHANGE 1-37 TO

. WORD 0,0,0,0,0

; INSERT BETWEEN 1-45 AND 1-46

. RECD #DKLB, #F1R0RB

; BEGIN RECORDING RECORD 0

. WAIT #DKLB

; WAIT FOR FINISH

; INSERT BETWEEN 1-85 AND 1-86

; FILE 1 RECORD BLOCK FOR

; RECORD 0

F1R0RB: . WORD 2
 . WORD PVCPID
 . WORD 230.
 . WORD 0,0

; CHANGE 1-89 TO

. WORD 230.

; CHANGE 1-101 TO

. WORD 194.

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COPY AVAILABLE TO DDC DOES NOT
PERMIT FULLY LEGIBLE PRODUCTION